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ABSTRACT

This module is designed to guide a class in analyzing and investigating energy attitudes and questions. It includes methods for establishing discussions and a classroom communication system. Sources and procedures for information gathering are suggested. Another section provides a broad overview of the energy situation with descriptions of present and possible future energy sources and baseline data on energy use. The remainder is devoted to definitions, principles and rules of inquiry governing each of the following subjects: (1) physical laws; (2) politics and law; (3) environmental impact; (4) attitudes and feelings; (5) health and safety; (6) design and technology; and (7) economics. A final discussion deals with valuing and decision making regarding possible energy futures. (TM)

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Attachment 1

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ENERGY AND HUMAN AFFAIRS

The Power Of Systematic Decision Making

SE 028 254

Biological Sciences Curriculum Study
EXPERIMENTAL EDITION 1975
2

BIOLOGICAL SCIENCES CURRICULUM STUDY

ENERGY AND HUMAN AFFAIRS: THE POWER OF SYSTEMATIC DECISION MAKING

STUDENT HANDBOOK

EXPERIMENTAL EDITION 1975

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Fact or fiction?

Using solar energy to generate electricity is possible, but too expensive right now.

Residential space heating is the number one use of energy in the United States.

Nuclear power plants provide less than one percent of the energy consumed in the United States.

More energy is wasted in transportation than any other energy use sector.

The United States has only six percent of the world's population, but uses 30 percent of the resources.

Natural gas burns cleaner than any other fossil fuel.

On they go: Energy facts. Energy fiction. Energy assumptions. Energy concerns. Energy opinions. Energy information and a great deal of energy *mis*information. Regardless of the quality of our knowledge or the nature of our attitudes, our consumption of energy continues -- and, perhaps more importantly, continues to increase.

It is apparent that at some future time, depending on consumption rates, fossil fuels, from which we currently obtain 95 percent of our energy, will run out. There also seems little doubt that a society such as ours cannot survive without adequate energy resources of some kind. Given these facts, everyone agrees that decisions must be made. But few can agree on what those decisions should be. We are bombarded daily with talk of rationing, tariffs, pipelines, oil shales, new explorations, nuclear power plants, solar energy research, using garbage as fuel, conservation, environmental disruption -- the list grows increasingly longer.

The options, the problems, and the interrelationships between energy decisions and societal concerns are varied and complex. In some cases, we lack the data necessary for solid decision making; we simply cannot accurately predict the consequences of a particular decision. For other energy-related decisions, data are abundant, but the decision means identifying personal and societal values and making trade-offs between one valued thing and another. How much air pollution are we willing to tolerate? How high a price can we pay for gasoline? In what ways are we willing to modify our

life styles in order to conserve energy? Obviously, there are no easy or simple answers to such multifaceted questions. But these very questions must be considered now and in the future if national and world energy problems are to be solved.

This module is designed to help you understand and analyze such questions. In your work so far, it is hoped that you have identified and evaluated your own energy attitudes and those of others. Discussion and research activities were intended to help you acquire some basic information about energy. Now you are ready to begin an investigation of your own. This book can serve as a resource as you plan and conduct your research.

You have already engaged in a series of discussions designed to help you select researchable energy questions that you consider interesting and important. Chapter 1 is a summary of that discussion pattern. It can serve to remind you of some of the relationships you should look for as you design and carry out your investigation. It also includes suggested mechanisms for getting the most from your research work.

Chapter 2 outlines a procedure for setting up a classroom communication system. Before you begin your project, work with others in the class to establish these classroom data sharing mechanisms. If everyone contributes regularly to the data bank, each team will have access to more information than would ever be available to one individual or group alone.

Once you have established your information sharing system, you are ready to begin your actual investigation. Chapter 3 suggests a number of sources and procedures for information gathering. Following the advice given there, you are sure to be successful in locating some (although probably not all) information pertinent to the questions you are trying to answer.

In Chapters 4 and 5, you will find some general information on energy resources and uses. These chapters are meant to provide only a broad overview of the total energy picture. In these chapters, you will find descriptions of present and possible future energy sources and baseline data on energy use in this country. If you are more interested in the international energy picture than just what is happening in this country, Chapter 5 includes one kind of comparison that can be made. You may want

to ask questions about other global energy concerns and find material related to them.

Chapters 6 through 11 are probably the most important in the book. As you already know, during the course of your investigation, you will be considering seven categories of factors that relate to energy questions. Not only must you consider each category, you must also attempt to find interrelationships between and among categories. Given the complexity of energy topics and the complicated interrelationships that exist among categories, you may feel at a loss as to how to begin. Chapters 6 through 11 can provide starting points. Each chapter includes some of the definitions, principles, and rules of inquiry that govern each subject matter area. Chapter 9, for example, deals with economics. In that section, you will find explanations of some general ideas in economics that occur again and again in virtually every economic problem or consideration. Although that chapter probably cannot answer the specific economic question you may be investigating, it can give you enough background information so that you can better understand material presented in books and papers on economics. The other chapters, PHYSICAL LAWS, POLITICS AND THE LAW, ENVIRONMENTAL IMPACT, ATTITUDES AND FEELINGS, HEALTH AND SAFETY, and DESIGN AND TECHNOLOGY have a similar purpose.

Perhaps your teacher has already discussed with you the purpose of this module and the end goal of your investigation. In essence, you are being asked to deal with decision making. The investigative steps, which include the collection, analysis, and interpretation of all available information related to a topic, are but one part of the decision-making process. Data never speak for themselves; all knowledge is subject to interpretation. Especially with questions that involve societal and individual values, empirical evidence and factual information may not be sufficient to the decision. Good decision making requires a reasoned assessment of both factual information and values. Most importantly, the consequences of a particular decision must be considered. At the end of your investigation, you will be called upon to make a recommendation. You will ask, "If I could make a recommendation to my community about (my topic), what would it be?" In Chapter 13, you will find a procedure for analyzing the information you have collected and the values you and your community have in order to arrive

at such a recommendation. As you work through this process, you may begin to understand something about the subtle interactions between facts and values that play such a critical role in decision making.

Chapter 14 outlines the final step in this module. When decisions are made, there are always consequences in the future. If you decide to buy a car now, you know that you will probably make car payments for some time. In addition, you must anticipate consequences such as payments for insurance, maintenance, repairs, fuel, and so on. These are consequences of the decision. If you decide *not* to buy a car, that decision also has consequences. The same sort of thinking applies to decisions made about energy issues. Whatever decisions we make today will have consequences in the future. The final activity, therefore, is the construction and presentation of a model for the future. Such models are sometimes called scenarios -- a "slice of life" in some future time. What kind of a future do you foresee, given a particular set of energy decisions that might be made now?

The authors of this program have attempted to design for you a unit of study that is challenging and significant. As a result of this study, do you feel that you know more about energy? Do you feel more confident to deal with complex social issues? Have you questioned or modified any of your original attitudes about energy? When you encounter similar situations in the future, are there things you will do differently? Your responses to these questions are the true evaluation measures of this module.

1. IDENTIFYING AND RESEARCHING ENERGY QUESTIONS

You have already engaged in a pattern of thought and discussion designed to help you identify a topic for your investigation. It is anticipated, also, that this pattern has helped you break your general area of interest down into smaller, more manageable components. You may even have specified researchable questions in some or all areas of your investigative design. This chapter will serve to review this process for you and to give you some idea of the direction you can take from this point.

You may recall that you began by naming all the energy use sectors you could think of. Specifically, you identified places and ways that energy is used in your community. Then you selected one of these sectors for analysis. You and other members of the class attempted to specify all the things that might affect the *amount* of energy used by that sector. You may have formulated long lists of such influences for one or more energy use sectors that were of interest to the class. The next step was to formulate some hypotheses -- some relationships between factors and the amount of energy used in a particular place or in a particular way. The question was, "If this factor increases, what will happen to energy use?" You may have decided, for example, that as the amount of insulation in a home increases, energy use goes down. Or that as the weight of a car increases, energy use goes up. No matter what energy use you chose to consider, you were probably able to identify many such plus and minus relationships. You may also realize that there are probably many more such relationships that you didn't think of.

This kind of thinking can be carried one step further. Perhaps you attempted to identify some "feedback loops," situations in which the result of an action can affect a similar action at some time in the future. For example, a homeowner who installs insulation and saves significant amounts of money on his utility bill may decide to increase the amount of insulation even more. Or a person who enjoys the convenience of electric appliances may decide to purchase still more such appliances -- in effect, increasing energy use and decreasing human labor in the home.

The search for relationships such as these may have led you to some decisions

about the topic you and your team want to investigate and the "sub-questions" that you will try to answer during the course of your investigation. You have been asked to consider seven categories of factors, no matter what your topic. These categories are

Physical Laws: those "laws of nature" that man cannot change, such as gravity, friction, etc.

Politics and the Law: governmental and public policies that restrict or permit individual and group actions.

Environmental Impact: the effects of energy decisions on the natural environment, including its living and non-living components.

Economics: Public and Private: essentially the "money questions" that individuals and societies encounter in relation to energy use.

Attitudes and Feelings: how public and individual opinion are formed and changed.

Health and Safety: the effects of energy decisions and use on human physical and mental well-being.

Design and Technology: the options and limitations of inventions and developments in relation to energy questions.

Have you been able to identify significant, researchable questions in each of these seven areas? Have you been able to decide what sources you will use in trying to answer each question? Since you are probably still working on this step of designing your investigation, an example of one group's investigation plan may help you. Remember, however, that this is only an example. Only *you* can determine what you are going to investigate.

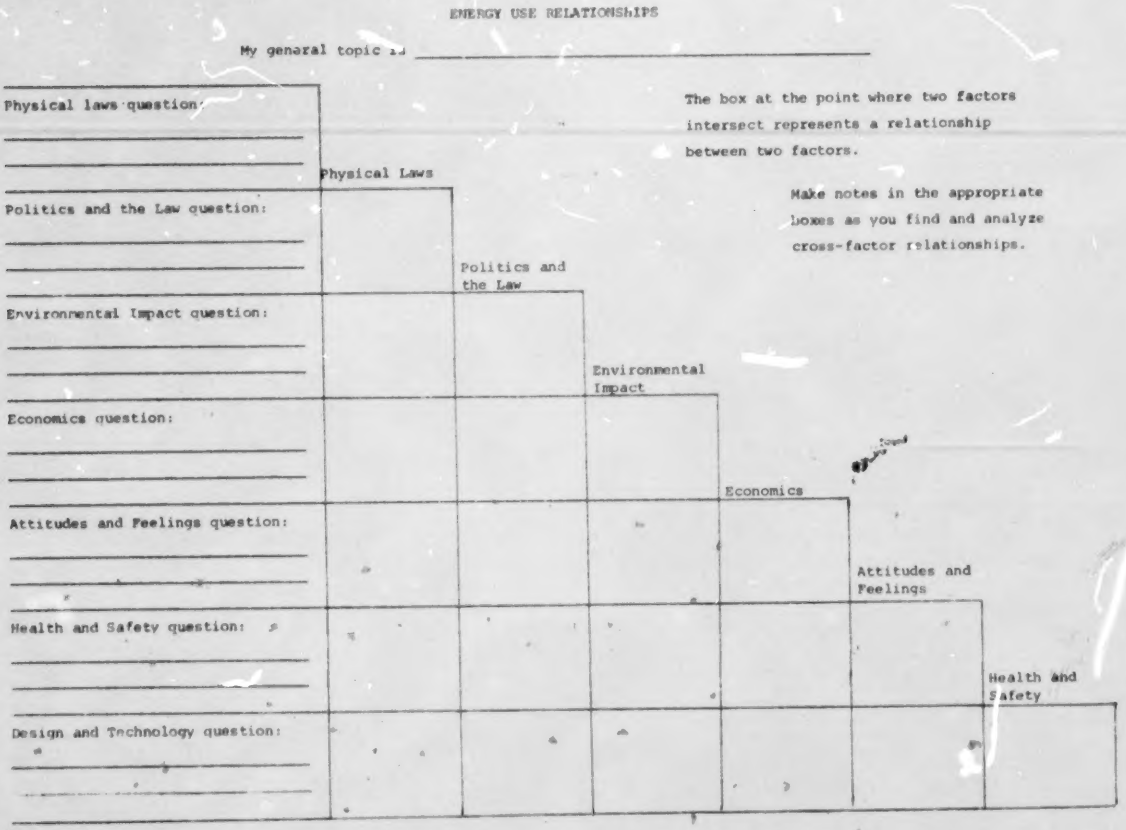
Perhaps you can see from this example that libraries, survey procedures, and site visits can be excellent sources of many different kinds of data. Perhaps you have noticed, also, that many of the questions overlap, or at least have obvious relationships to one another. In other words, each category relates to every other category in some way. These relationships between and among categories are extremely important. It would be unrealistic to explore any one category alone. To help you identify and describe the interrelationships, you are being provided with one additional tool that you can use throughout your investigation. This tool is the

Topic of Investigation

ENERGY USE IN HOME LAWNS AND GARDENS

Physical Laws	
Will soil treated with animal fertilizer grow as good a crop as soil treated with synthetic, chemical fertilizers?	Experiment--grow a crop in both kinds of soil Libraries Interviews with gardeners who have used both
Politics and the Law	
Are there legal restrictions on kinds or amounts of fertilizers home gardeners can use?	Interviews with city, county, and state lawmakers, lawyers, extension agents, etc. Interviews or correspondence with fertilizer producers Law library and municipal records
Environmental Impact	
Do fertilizer plants produce pollutants? If so, what kinds and how are they handled?	Tour of a fertilizer plant and interviews with employees Correspondence with fertilizer manufacturers Lawyers and law libraries (to see if fertilizer manufacturers have ever been sued for polluting)
Economics: Public and Private	
If the price of commercial fertilizers were to rise, would people switch to animal wastes for fertilizer?	Interviews with home gardeners
Attitudes and Feelings	
Are people with home gardens more energy-conservation-minded than people without home gardens?	Structured interviews or questionnaires to people with or without home gardens Data might include number and kind of cars, thermostat setting, amount of home insulation, etc.
Health and Safety	
Are people with home gardens more physically fit than people without home gardens?	Structured interviews or questionnaires to both groups Data might include time spent gardening, number of illnesses during last year, nature of diet, other sport or athletic activities, etc.
Design and Technology	
How much energy goes into the production of fertilizers for home gardens? What kinds of equipment are used?	Tour of fertilizer factory Interviews or correspondence with fertilizer manufacturers Library research

matrix worksheet that looks like this:


ENERGY USE RELATIONSHIPS
My general topic is
The box at the point where two factors intersect represents a relationship between two factors.
Make notes in the appropriate boxes as you find and analyze cross-factor relationships.
Physical laws question:
Physical Laws
Politics and the Law question:
Politics and the Law
Environmental Impact question:
Environmental Impact
Economics question:
Economics
Attitudes and Feelings question:
Attitudes and Feelings
Health and Safety question:
Health and Safety
Design and Technology question:

You can use this matrix to identify relationships between two categories whenever you come across them or think of them during your investigation. This matrix will, in fact, be used in several ways. Two large matrices just like this one will serve as data-sharing devices for the entire class (see Chapter 2, ESTABLISHING THE CLASSROOM DATA BANK).

Begin now to clarify the questions you want to investigate and the sources you can use to try to answer your questions. Get your team organized so that tasks can be delegated and shared for the best use of time and available resources. Also, start to use the matrix to record energy use interrelationships.

Spend some time in this planning phase. Planning pays off later. And don't forget two valuable resources that are available to you for designing and conducting your investigation. The first is your teacher. Your teacher cannot answer your questions for you, but he or she can assist you in

clarifying your thinking and working out your own plan of action. The second tool you can use is this book. Every chapter in this book contains information about energy questions and factors and suggests techniques or sources of information. Review the INTRODUCTION and the CONTENTS to see what information and techniques included in this book can be useful to you.

One additional reminder -- at the end of your investigation, you will be asked to prepare a hypothetical recommendation to your community. You will ask yourself, "If I could advise my community on (my topic), what would I suggest?" Arriving at this kind of *tentative* conclusion is the whole purpose of your investigation. So that you will have some idea of "where this whole thing is going," read Chapter 13 before you begin your research.

2. ESTABLISHING A CLASSROOM DATA BANK

Now that you have identified energy relationships and have asked some questions about those relationships, you are ready to begin investigating various aspects of the broad energy question. But your questions -- or the questions of your group -- may appear to be very different from the questions selected by other individuals or groups within the class. Thus, because understanding of how each component fits into the more general energy issue is one goal of this module, it is important that you establish and implement mechanisms for pooling and sharing all the data the class collects. In addition, because different investigations may yield different insights or may bring different problems to light, communication among all class members is essential if you are to gain understandings broader than those your particular investigation may allow. The following procedure will allow you to establish a classroom data bank that can serve as a device for sharing data and ideas.

The matrix you have already used in defining your investigation questions is probably the best organizational scheme for the entire class to use. Select *two* places in the room where giant matrices can be placed. Depending on the design of your classroom, you may decide to copy blank matrices onto blackboards or to prepare large matrices on pieced-together butcher paper to be taped to the walls. The only requirement to keep in mind is that the bigger the matrix is, the easier it will be to work with. Make two giant matrices and use them as described below:

Matrix I: "What's in the News?"

Scan the newspaper at regular intervals -- every day, if you can -- looking for news reports, advertisements, editorials, and letters to the editor about energy-related problems. Also check magazines for similar materials. Cut out the things you find and bring them to class. Read the article carefully, analyzing the writer's intent and message. In most cases, you will find that the article "fits" quite neatly into one or more of the boxes in the matrix (see Chapter 1). Indeed, it is likely that nothing would have been written about the matter were there not some relationship or conflict between two areas of concern as specified on the matrix. Post the article in the box where you think it belongs. Write your name on the clipping so

other class members can talk with you about it. At regular intervals review the articles you and the others have added to the matrix. Ask yourself why each article has been placed in a particular box. Discuss the articles with other students. As your matrix begins to fill up, look especially for articles that fit in boxes that are empty. Can you find examples of all the relationships suggested by the matrix?

Matrix II: "Whaddja Get?"

During the course of your investigation, you will be collecting information from a variety of sources. As you consider your data, you will probably come up with new ideas and new questions that you had not thought of before. It is also likely that some of the information you gather and some of your new ideas and questions will relate to the investigations of other teams or individuals in the class -- even though their investigations are directed toward topics and questions that appear very different from yours. Similarly, the information other students assemble may turn out to have important applications in your study. Thus, there is a tremendous value in establishing a "class communication system" -- a device for pooling information and insights. The second large matrix can serve this purpose.

Whenever you find some data or recognize some problem that you were not aware of before, write a short description in the appropriate matrix box. Sign your name to each entry so that others in the class can ask you about the finding or idea. Review the matrix periodically, studying the entries that others have made and thinking about the relationship of their work to your own. If some boxes become crowded and others remain blank, consider modifying the plan of your investigation so that you can provide an important "piece of the puzzle" that others may have overlooked. Keep the matrix active, growing, and up to date. It can be the most useful organizational tool and the most comprehensive resource available to you.

3. TECHNIQUES FOR GATHERING INFORMATION

Some of the data or information that you need for your investigation may already have been collected by a branch of the government, a private organization, or an individual. Five major resources in your community, and the type of information most readily available from each, are

LIBRARIES	Statistics, census data, background information, reports of previous investigations on your questions
GOVERNMENT AGENCIES	Government policy, laws, regulations, and how they are being implemented and enforced; records of violations and complaints; copies of government studies or investigations
BUSINESS AND INDUSTRY	Information about their own products or services; results of research to create and develop new products
PRIVATE ORGANIZATIONS	Data and information which they have collected, suggestions regarding viewpoints worth considering, resources that they have found useful, what they are doing and why, what they think still needs to be done
LOCAL COLLEGES OR UNIVERSITIES	Information and advice from experts in specific fields, data from groups or individuals doing research, library materials which may not be available at the public library

Additional information and suggestions for using libraries or contacting government or private agencies and organizations are provided later in this chapter. *Caution:* The opinions and interpretations you get from different sources may vary considerably. The best policy is to gather the same information from at least two different sources and compare the data and viewpoints represented.

How Can I Get in Touch with ...?

By far the fastest way to contact someone or get a piece of information is by making a phone call. If you don't know exactly which office or person might have the information you want, ask a few well-directed questions by phone. Don't write letters unless there's no way to get the information locally by phone or in person. Even if you want to receive something in the mail, ask for it by phone. The telephone directory, especially the Yellow Pages, is one of the most valuable resources available to you. Suggestions for using the phone book to identify organizations and agencies

in your community are included later in this chapter.

Most agencies and organizations will be happy to assist you if your requests are specific and sincere. Request information on a narrowly defined question, rather than on a topic as broad as "air pollution." Don't ask for information that is available from the school or local library.

Before making a phone call, jot down exactly what you intend to say. Identify yourself and your school, and briefly describe the nature of your project and the intended use of the information. Then request the specific data or information that you are seeking. Make your call as short and to the point as possible.

Try to direct your request to a specific person or department. A receptionist, secretary, or switchboard operator will probably answer your call and ask, "Whom would you like to speak to?" If you don't know the name of the person, refer to the title of the position he or she holds ("May I speak with the person in charge of energy use planning for the city?"), or by a brief description of what you want ("I'd like to speak with someone who handles proposed changes in utility rate structures.") Be ready to *write down* the person's name.

If you are told that the person you'd like to talk to is not there or is busy, don't just say, "Okay, thank you" and hang up. Ask when the person will be in or "what would be the best time to call back?" Then write yourself a reminder to call again at the suggested time. Be persistent! You may have to call several times. If the person you reach informs you that he or she can't provide you with the information that you need, ask that person to suggest another source you might try.

Is There a Law?

Where do you go to find out if there is a law about something? All of us know that the easiest way to find out about some laws is by asking at the police station. But if you want to find out whether there are laws governing industrial utility rates, insulation in houses and public buildings, or street lighting, whom do you ask?

Look in the Yellow Pages of the phone book under "Government." The duties of most departments are obvious (for instance, the Parks Department makes

sure that rules regulating parks are followed). Once you have found the appropriate branch of government, the people there will be able to explain to you the laws that they enforce. In most cases, the city government officials will be able to tell you about county, state, and federal regulations, as well as city laws. Sometimes county and state departments are even responsible for monitoring federal standards.

Government agencies responsible for enforcing laws must keep records of the number of violations. In addition to illegal acts that they find, they also receive complaints from citizens who report infringements of the law. Records showing the number of complaints and violations, their location and nature, are available to the public.

If changes in laws are being proposed by government agencies, those agencies should be able to direct you to someone who could discuss them with you. Members of the U. S. House of Representatives and Senate have local offices in many communities. These offices are in daily contact with the legislators in Washington, D. C., and will be able to answer many of your questions about federal legislation. Look in the Yellow Pages under "Government, United States -- Representative or Senator."

Occasionally, new laws are formulated when groups of citizens initiate the change through petitions or lobbying. Some of the private organizations listed later in this section may be active in your community. A few well-directed phone calls should enable you to determine whether any local groups are actively trying to influence the government on energy questions.

Library Resources

Your classroom and school libraries contain a variety of materials that may be useful in your investigation. In your classroom library you will find books and pamphlets that have been especially selected because of their potential use for energy investigations. Find out what's available in your classroom and school libraries before going to the public library.

If your community has more than one library, you probably already have discovered that you can save time by going to the main library where the central card catalog is located. Your library contains many things other than books that may be much more valuable in your investigation. Ask the librarian to show you where to find and how to use the following:

The *Vertical File* is a collection of pamphlets and articles that have been organized by subject in folders. You may even find files with brochures, newspaper clippings, maps, and paperback books. In other words, this is a place where you can find many tidbits of information that are not printed in books and may be just what you need; for example, leaflets used last year by groups campaigning for and against a change in utility rate structure.

Periodicals, magazines and journals that are printed at regular intervals, are probably your best source of current information on topics that change rapidly, such as solar energy development and applications, or the politics and economics of oil import problems. By using the *Reader's Guide to Periodical Literature*, you can easily check to see if an article of interest to you has been printed in the last year or two. If the library does not have an article that you want, ask if they can borrow it for you from another library.

Newspapers are especially useful in following the day-to-day progress of a current issue or in reviewing events which occurred in the past but were not recorded in any other publications. Your library may have an index for past issues of the local paper. If not, you will have to search for articles on your topic by guessing the dates that such articles appeared and looking through newspapers printed on those dates.

Government Documents is the general name given to thousands of pamphlets, reports, and books printed each month by the federal government on every topic you can imagine. You should be able to find out if there are any government documents of interest to you by using the *U. S. Government Publications Monthly Catalog*. The December catalog contains a subject index of all materials printed during the year. Most libraries have one of these catalogs, but you may have to ask the librarian for it. To give you an idea of the variety of energy-related material available in the form of government documents, look at the titles of just a few publications that were listed in the March 1975 Monthly Catalog.

1974 Financial Report, Atomic Energy Commission

Questions about the Ocean

Analyses of Natural Gases

Occupational Injuries and Illnesses by Industry, 1972

The City as a Biological Community

Energy Reorganization Act

Environmental Factors in Coal Liquefaction Plant Design

Federal depositories are libraries all over the country in which materials published by the federal government are placed. There are several of them located in each state. Your public librarian can show you a list of the depositories in your state. Each federal depository has copies of most, if not all, government documents.

Government Departments and Agencies

You will find government departments and agencies in your community listed in the Yellow Pages under "Government." Check your phone book for the following offices:

The Environmental Protection Agency (EPA) is an independent federal agency organized to protect and to improve the environment. It has broad responsibilities for research, standard setting, monitoring, and the enforcement of laws and guidelines related to six environmental hazards: air pollution, water pollution, solid waste disposal, radiation, noise, and pesticides.

The Department of the Interior has several energy-related offices.

1. The Bureau of Mines is concerned with mineral fuels, mineral economics, conservation of minerals, annual mineral production, consumption, imports, exports, and prices by commodity and state.

2. The Office of Oil and Gas is concerned with government policies for oil and gas and with liaison with, and national and international emergency planning for, the petroleum and natural gas industries.

3. The Geological Survey is concerned with the nation's mineral and water resources, supervision of mineral, oil, and gas leases on federal and Indian lands, and classification of public lands for mineral and water power potential.

4. The Office of Coal Research finances research to develop methods of converting coal into clean alternative energy forms.

5. The Bureau of Reclamation's interests include the generation, transmission, and sale of hydroelectric energy and geothermal resources.

The Federal Power Commission deals with generation, transmission, and distribution of electricity; production and transportation of natural gas; energy sources; pooling systems (interconnection and coordination of facilities); charges for interstate transmission and sale of electricity and natural gas; conservation and development of natural resources as related to licensing of power projects and natural gas production; construction of hydroelectric projects; public utility valuation, depreciation, and rate structure; import and export of natural gas and export of electric power; and mineral resources.

The Power Supply, Management and Engineering Standards Division of the Rural Electrification Administration, U. S. Department of Agriculture, answers inquiries on engineering related to the design, construction, operation, and maintenance of electricity distribution, transmission and generation facilities in rural areas.

Congressional Committees. Call the office of your Representative or Senator for information on the activities of these committees:

1. Joint Committee on Atomic Energy. Provides information on all atomic energy matters pertaining to military and civilian development, use, and control.

2. Committee on Interior and Insular Affairs, U. S. Senate. Concerned with energy resources, mining and minerals, and related legislation.

3. Committee on Interior and Insular Affairs, U. S. House of Representatives. Concerned with hydroelectric power programs, mineral resources of public and Indian lands, and mining interests generally.

Research, Industry and University Groups

Depending on where you live, some of the following organizations may be able to help you. But, remember, do not write vague letters asking for all information available. If these organizations have offices near you, call and ask for specific information. If you are far away from any of these addresses, check your library in the AUTHOR index. You may find publications produced by these groups.

One additional word of caution. Some of these organizations have special interests, perhaps even biases. Never settle for a single, or even a few, sources of information on a topic. You could miss important data and controversial points of view.

Central Abstracting and Indexing Service
American Petroleum Institute
275 Madison Avenue, 9th Floor
New York, New York 10017

Library, American Petroleum Institute
1801 K Street, N. W.
Washington, D. C. 20006

Information Services Department
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Private Organizations

To find the private organizations in your community that may help you, look in your telephone book. Some phone books have a Yellow Pages Index. If yours has an index, check it for headings related to your topic. If and organization is not listed in the Yellow or White Pages, don't assume that the group does not exist in your community. Many active organizations can't afford an office and phone listing. The library usually has a list of such groups, including the name and phone number of the chairman or

someone who can answer questions about the organization.

Here are a few organizations that might be able to help you. (*Reminder:* Look for biases in the information you obtain from these sources. Other organizations may draw very different conclusions from the same data.)

Sierra Club
Soil Conservation of America
National Audubon Society
Isaak Walton League
National Association of Conservation Districts
Soil Conservation Society
American Institute of Architects
Environmental Defense Fund
Common Cause
League of Women Voters
American Medical Association
American Cancer Society
March of Dimes
Tuberculosis and Respiratory Disease Association
The Wilderness Society
Wildlife Federation
Your public utility ("private" in the sense that most are investor-owned)

Collecting Data on Public Opinion

Much of the data you will need for your investigation may be available in libraries and from public and private agencies. There is one important area, however, where you may decide to collect your own data. This is the topic of attitudes and feelings, or public opinion. This information will be very important when the time comes for you to make your recommendation for the community (see Chapter 13, VALUING AND DECISION MAKING). The following paragraphs describe a few techniques for obtaining data about people's thoughts and values.

Defining and Sampling the Population

A population includes all the members of any group you decide to study. It may be very large or quite small. For example, all the people living in the United States make up a population; all the students in the United States are another; even the students in your class are a population. Your data and interpretations can only apply to the population you have studied. Be sure to start by defining the entire population you wish to investigate.

If you can't possibly work with the entire population, you can select a

sample that is representative of the large population you have in mind. The Gallup Poll reports are based on data from a sample of a few thousand people who represent the entire population. You are probably thinking that data based on samples might be different from that of the whole population. You're right; errors do occur. But the chance of error can be very small if *random sampling* is used and if the sample is not too small.

Let's look at a few sampling techniques that could be used to obtain a random sample. To sample the students in your class, you might put all their names in a hat and draw five. The sample would be nearly random. Or, suppose you wanted to use a telephone interview to gather data about the opinions of people in your community on some problem or issue. You couldn't call everyone who is listed, but you might decide to call every fifth or every tenth person listed. This could give you a very nearly random sample. (Of course, you will miss the people who do not have phones and others who have unlisted numbers. Will missing these segments of the population affect the outcome? You may also get a biased sample unless you call at a time when most people are home.)

Deciding what *sample size* should be used is difficult. Common sense will help you decide how many to include, but there are a few guidelines that may help. First, use as large a sample as you can in the time you have available. If you are gathering information from a small population, like data on gasoline mileage from local car dealers, or on the energy opinions of each member at a meeting of the city council, you will probably be able to include the whole population in your study. But if you are trying to survey a representative group of people in a large population, it is important that the sample be chosen as randomly as possible and that it include at least 30 or 40 individuals. Begin with more than 40 names, since some people will not participate.

Selecting a Survey Method

The following descriptions of questionnaires and interviews, and how and when to use them, can help you decide which technique is most appropriate for your investigation.

A *questionnaire* is a written survey that is handed out or mailed to be filled out by the respondent. Questionnaires can be completed in the

presence of the investigator, or they can be distributed and picked up later or returned by mail.

Since questionnaires are in written form and can be completed independently by the respondent, they have many advantages. First, you do not need to contact each participant personally. Therefore, you can get responses from a large number of people in a relatively short time. Since the questionnaire is written, you can be positive that all participants are responding to exactly the same questions. Because people completing the questionnaires do not have to sign them, they may be more honest and frank in their responses.

The main difference between a questionnaire and an *interview* is the manner in which the questions are asked. In an interview, the investigator questions each person individually and receives an oral reply. The investigator can immediately clarify anything that the respondent does not understand. There are two ways to conduct an interview. Each one is used for a different purpose and produces different kinds of results. Be sure that you use the one that will allow you to collect the kind of information you need.

Conversational interviews are simple, informal question-answer sessions. They are useful in gathering background information or in learning about something from experts. But they also have definite limitations. Contacting and interviewing people in this manner usually takes a lot of time. And, since each participant is not asked exactly the same questions in the same way, the answers collected from different respondents *cannot* be compared with one another.

If you plan to compare the responses of two or more people, you must conduct the interviews in a different way. This second method is called a *structured interview*, because each participant is asked exactly the same questions in the same manner. Afterward, the responses can be compared. Use structured interviews to find out how many people think alike or do something the same way, or whether one group of people is different in particular ways from another group. The major drawback is the time required, although it takes less time than a conversational interview. One way to save some time is to contact the people by phone instead of

going around town talking to them in person. Another way is to divide the work up among several members of a team. Make sure, however, that each interviewer asks exactly the same questions in the same way. Remember, unless the questions are the same, the answers cannot be compared, added to get a total, or used together in any other way.

Deciding What to Ask and How to Ask It

This section deals with some basic ideas you should consider as you prepare your questionnaire or interview. Essentially, the process includes (1) defining the problem, (2) writing and classifying questions, (3) applying criteria to judge the quality of the questions, and (4) organizing the questions in the survey document.

1. *Steps in Defining the Problem*

a. Write down and think about as many aspects of the problem as you can.

b. Talk with friends, teachers, neighbors, and others about the question. Talk with government officials, members of private organizations, businessmen, and people older and younger than you are to get a variety of opinions on the subject.

At this stage, you will be working with very "open" questions. As you talk with people or search for background information, you might begin with questions such as the following:

How do people feel about driving smaller cars?

c. Describe the problem as it now exists, based on the background information from your preliminary discussions. For example: *About one-third of the people we talked to already drive compact cars. Some others feel that large cars are necessary for their families and businesses. Car dealers say that gas mileage on large cars is being steadily improved and would-be even better if air pollution control standards were reduced.*

d. Make a list of the aspects of the problem that you think should be studied. Include some of the questions that you'd like to get answers to.

2. *Writing and Classifying Questions*

One useful way of classifying questions is by the length of response required.

Questions that call for a response of only one to a few words can be described as *closed* questions. The common types of closed questions are:

Fixed choice. The respondent chooses from two or more responses offered. For example,

What size car do you drive?

☐ Mid-size ☐ Compact ☐ Subcompact ☐ Don't drive

Scaled choice. The respondent chooses from a given range of responses. For example, *In your opinion, how much of the responsibility for conserving energy should be taken by each of the people or groups listed below? Please rate each one on a scale from 1 to 4, circling the appropriate number.*

	no responsibility			major responsibility
Private individuals	1	2	3	4
Groups of concern citizens	1	2	3	4
Voluntary organizations	1	2	3	4
Businessmen	1	2	3	4
Government agencies	1	2	3	4

Or the responses may be designated by words, *The government should take the major responsibility for energy conservation.* ☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

Short answer. This type asks for specific information like place, time, or object. For example, *How often do you ride the bus?*

Yes-No. Example: *When you think of air pollution, do you think of smoke?*

☐ Yes ☐ No ☐ Don't know

Any of these four types of closed questions produces responses that can easily be totaled, compared, or otherwise organized for interpretation. They supply data about specific aspects of your investigation.

Questions that call for responses of more than a few words are known as *open* questions. An example is, *How does the recent increase in electricity rates affect you and your family?* Open questions will help you learn about the broad aspects of your problem.

3. *Judging the Quality of the Questions*

The following suggestions should be useful as you prepare your survey questions:

a. Write questions that relate directly and specifically to your problem. For example,

Poor	Better
How do you feel about energy conservation?	*Are you for or against gasoline rationing?*

b. Choose questions to meet specific needs. If you are interested in general attitudes or opinions, open questions are more useful than closed questions. For example, *What do you think are the most important problems facing our country today?*

c. If you wish to gather precise opinions or specific bits of information, closed questions that limit the possible responses are usually best. Responses to closed questions can easily be

tallied for comparisons or to find out where the majority stands. For example, *Do you think this country can do without imported oil?*

☐ Yes ☐ No ☐ Don't know

d. Make your questions clear to the respondents. Unless a question means the same thing to each respondent, your results will have little meaning. Consider these examples:

Poor	Better
Do you think that there is an energy crisis?	*Do you think the U. S. is likely to face a serious shortage of petroleum in the next ten years?*

e. Avoid leading questions that tend to make one answer more likely than another. These will bias your data. Consider these examples:

Leading	Better
What do you think of this terrible energy [illegible]is?	*Do you think the U. S. should limit oil imports?*

f. Avoid questions that ask for information the respondent does not have. Suppose you asked, *How many miles do you drive each week?* and the respondent has no car. Begin by asking the basic question.

4. *Organizing the Questions*

The size and organization of a survey document can influence the responses. No interview or questionnaire should require more than thirty minutes to complete. Limit phone interviews to no more than ten minutes. The following ideas may be useful in organizing your items.

Before you ask anyone to participate in your survey, explain who you are in an understandable and nonthreatening manner, and briefly tell why you are conducting a survey.

If you are mailing a questionnaire, put a cover note on it (or a paragraph at the top) to explain who is conducting the survey, and why. Be careful to avoid statements that might bias the responses. For example, respondents might answer questions differently if you said in the introduction, *We are conducting a survey to find out people's opinions about the energy problem in our community*, than if you said, *We are studying energy use in our community*. In the first case, the sentence tells the respondent that the community has an energy problem. The latter example is not leading; the respondent must decide whether or not the community has an energy problem.

If you plan to deliver a questionnaire personally, or if you will interview the respondents in person or by phone, your introduction will be spoken instead of written. You might say something like this:

Hello, my name is _____. I am a student at _____ and I am conducting a study of _____. May I ask you a few questions to help with the study?

If the respondent is hesitant about cooperating, try to decide the probable cause and act accordingly. Depending on your analysis, you might say:

I'm not selling anything; I would just like your opinion.

This will just take a few minutes.

There aren't any right or wrong answers.

Could I call back at another time, and would you suggest when?

Not every respondent will be cooperative. Don't argue if your call or visit is taken as an intrusion.

Begin your survey document with the simpler questions and proceed to the more complex ones, especially if the survey will take more than three to five minutes. It is not easy for the respondents to break off an interview or ignore a questionnaire after they have answered several of the questions.

Organize your survey document so that the questions flow smoothly from one area of concern to the next; don't jump back and forth. Place related questions together. Topics containing the most complex questions should come last.

Avoid sudden requests for personal information. If you must ask questions that are potentially embarrassing, give the respondent an opportunity to explain. For example, if the respondent has said that his community has pollution problems, and you ask, *What have you personally done about them?* you may give him or her a feeling of guilt. Ask, instead, what has been done or should be done about the problem.

Data on age, occupation, income, and such things is personal and potentially embarrassing. Place such questions near the end of the interview or questionnaire. If the respondent does not want to reveal some of this information, his reaction will not have influenced all the rest of his answers as well.

Testing Your Survey Procedure

When your survey document is ready, test it on a sample population. This

is a kind of "dress rehearsal." Run a pretest of the whole survey with a first group of respondents. Make every step exact, just as you plan it for the actual data gathering. After you pretest your survey document, consider the following criteria in making judgments about individual questions:

"All-or-None" responses. If all, or almost all, respondents answered the same way, you can suspect that the question has drawn a "type" response and should be reworded. It may be a leading question, or it may have been asked in such a way that it missed the specific area of controversy.

Many "I don't know" or "I don't understand" responses. Unless you were trying to find out how many people were uninformed about an issue, too many "don't knows" indicate poor questions or poor design. Consider the following possibilities: (a) the questions are vague; (b) the questions are too complicated; (c) the answers are complicated and the respondent needs help in formulating them; (d) the respondents do not have the experience or information needed to answer the questions.

Qualified Answers and Irrelevant Comments. Qualified answers suggest that the choices offered respondents were too limited. Irrelevant comments suggest vague questions, or choices of answers that did not relate closely enough to the question. Think carefully about the comments for they will frequently suggest a degree of modification or further precision required of your questions.

Many Refusals to Answer Questions. If more than five percent of the pretest respondents refuse to answer a question, check the following:

a. Too many personal questions may be in the survey, and the respondent feels threatened or is suspicious. Even in the case of an anonymous questionnaire, the respondent may feel that the answers he gives will reveal his identity.
b. Personal questions may be asked too abruptly or are out of place.

Analyzing the Data

A stack of completed questionnaires, taped recordings of interviews, a data book full of detailed notes -- each contains a great deal of information. But this information is not very useful until it is organized. Arrange your data in some sort of orderly manner; you will probably be able to figure out what it means more easily.

Grouping. Data with similar characteristics can be grouped together. For example, your observations may fall into groups based on the time of day or the place they were made. Or you may compare survey responses from older and younger people. Are there any differences between the groups? Once you have divided your data into two or three main groups, you may be able to break down those groups into subgroups based on other characteristics.

Tallying. This is a simple technique that is useful in finding out how many people, things, or responses fall into each group or category. For example,

	15 or more hours	7-15 hours	5-7 hours	2-5 hours	2 hours or less	no time
Time spent driving each week	~~HHH~~ I	IIII	~~HHH~~ III	~~HHH~~	~~HHH~~ ~~HHH~~	~~HHH~~

Calculating Percentages. Figuring out what percentage of the population falls into each category usually makes it easier to compare one group with another.

Making Charts, Tables, or Graphs. Making sense out of large collections of data is easier if the data are organized in a chart, table, or graph. When the data are presented in such a manner, basic trends or patterns in the information can be seen at a glance.

4. ENERGY RESOURCES

The things that people do require great quantities of energy. In an earlier time, the only energy people used was food energy -- the energy of the sun that is trapped in plants. With advancing civilization, energy use grew far beyond basic food requirements. Today, most of the things we do and all of the products we use rely on considerable energy input. Virtually all that input comes from one source -- fossil fuels. Fossil fuels are coal, oil, and natural gas -- the remains of plants and animals that lived millions of years ago. Should these sources of energy cease to be available, the things we do and the way we do them would change significantly. How great the change would be depends on a number of related questions such as "Can another source of energy be used for the same purpose?" or "Can some other activities be as useful and satisfying?" The problem is that fossil fuels will run out -- sooner or later -- and given our present rate of consumption, that future time seems not so far distant.

Your studies in this module will be directed toward the current status of the energy supply that is available to maintain our activities and toward the numerous decisions that we must make about the energy sources we use and how we use them. The supply of energy and the sources from which it comes constitute our *energy resources*. Since these resources exist in several forms, the ways in which the energy is derived from them also differ. In many instances, the way we use energy from a particular source depends on the form in which it is most readily available to us.

For example, it was discovered long ago that the energy contained in water flowing downstream could be used to transport people and materials. As a consequence of this discovery, major industries and transportation centers grew up along the edges of large bodies of water. Subsequent inventions such as propellers and engines made movement against the current more effective, but they demand expenditures of energy from other sources to counteract the force of the downstream flow. Similarly, fossil fuels have been heavily exploited because of their ready availability, ease of handling, and relatively low cost. Only as availability decreases and cost increases are people likely to consider alternative energy sources or changes in energy use patterns. The problem is -- that time seems to have arrived.

The question is really not that of total energy supply but of the *form* in which the supply exists. The earth is literally flooded each day with energy -- energy from the sun. But the technology that would allow us to use the sun's energy for heating, lighting, manufacturing, and transportation is still extremely crude. Fossil fuels, in contrast, constitute an easily extracted, concentrated, and simple-to-use source of stored energy. There are other sources of energy that might be available for human use, but, like fossil fuels, they all have both advantages and disadvantages. The following sections identify some of those sources and provide some discussion of the potentials and limitations associated with each.

Fossil Fuels

Coal, oil, and natural gas are the result of organic deposits (the remains of living animals and plants) laid down and buried beneath the surface of the earth millions of years ago. Chemical changes brought about by heat, pressure, and decay resulted in some deposits becoming solid (coal), some liquid (oil), and still others gaseous (natural gas). The discovery of these deposits and their usefulness has led to extensive drilling and mining operations around the world and to great dependence on fossil fuels as a primary source of energy in this country and elsewhere. Because the supply of these fuels is finite and nonrenewable, we know that the faster we use them, the faster they will be used up.

The usefulness of these fuels for energy production varies with the physical and chemical characteristics of each deposit. Lower grade coals, for example, are more difficult to handle and release less energy per unit of weight than higher grades. In addition, the burning of coal can release sulfur oxides, ash, smoke, and soot into the air.

Other concerns also affect the use of fossil fuels. Natural gas, while the least polluting of fuels, is also in shortest supply. Estimates of how long it will last vary between 13 and 35 years at present consumption rates. Coal is relatively plentiful, but almost all known high grade deposits have already been mined and used; only lower grades remain. Associated with coal mining are problems of safety, distribution, esthetics, and environmental disruption. Sizable reserves of oil exist in the Middle East, but the politics and economics of extensive importation of that oil could create balance of payment and balance of power problems for the United States.

One process for extracting more useful energy from fossil fuels is currently being studied, although funding for the research is scarce. This process called MHD (magnetohydrodynamic) converts heat from combustion gases directly into electricity. (Ordinarily, that heat would be discharged into the air and lost.) Although MHD could theoretically result in 25 to 50 percent more electrical energy from each unit of fossil fuel, this technology, like processes being considered for producing synthetic gas and oil, is plagued with engineering and economic problems.

Nuclear Energy

When the nucleus of a radioactive uranium atom breaks down, heat is released. This heat can be used to generate electricity. The process of speeding up natural radioactive decay is called "splitting the atom" or "fission." It is the basis for such recent innovations as the atomic bomb and nuclear power plants that can heat water to generate electricity or propel a nuclear submarine. Another kind of nuclear energy is fusion. In some ways, it is the opposite of fission. When two small atoms join, energy is released. The hydrogen bomb is a fusion reaction; the atomic bomb is a fission process. Scientists have had far less success with fusion than with fission, primarily because of the tremendously high temperatures required and the difficulty of containing the hot plasma.

Fission reactors currently supply less than one percent of the nation's power, but many new nuclear power plants are either planned or are actually under construction. Nuclear power, for all its potential, has some serious problems. One concern is that nuclear fuels tend to release energy in ways that can disrupt and destroy living tissue. This property remains in the waste products after the fuel is used. Substantial measures, such as thick lead shielding, are required to protect human and other life from the fatal effects of radioactivity in the environment. Although nuclear fuel is relatively easy to mine and transport, the possibilities of theft and accident are real and potentially disastrous.

Geothermal Energy

The source of geothermal energy is essentially a huge nuclear "reactor" -- the earth's core. Natural radioactive decay at the center of the earth produces heat that sometimes comes to the surface as hot water, hot rock,

or steam. In California, there are now geothermal power plants that use hot springs for generating electricity. Even in areas where the heat does not come to the surface naturally, it is possible to drill deep into the earth to capture its heat. Although geothermal plants cost less to build and operate than conventional power plants, they are not without their problems. Such plants create considerable air and thermal pollution. They also produce very salty waste water which can harm the environment and corrode the equipment. It is even possible that deep drilling could cause earthquakes.

Solar Energy

The sun's energy is, for all practical purposes, an infinite resource. Technological means now exist for using solar energy in two ways. One way is to capture sunlight as heat and use it directly for heating and cooling a home, school, or business. Some scientists believe that within five years, such units will be commercially available at prices that can compete with those of conventional furnaces and air conditioners. The other process involves using the sun's energy to generate electricity which can then be stored in batteries until needed. The solar cells needed for this are much too expensive to make the process feasible now, but some scientists and designers see cost reductions as possible in the near future. Although solar-heated houses and schools now exist and numerous plans for solar-powered devices are available, this technology -- like all others --is plagued by certain difficult problems. Solar heating units, for example, cost more to install (although less to operate) than conventional furnaces. Building contractors and potential home buyers are unlikely to welcome higher costs for houses. A miniature solar power plant is already operating in Senegal, but the economic and distribution questions one might ask about such a plant are still unanswered.

Solid Wastes

Manure, food wastes, and industrial wastes can be turned into gas or oil. Any one of three processes -- hydrogenation, pyrolysis (destructive distillation), or bioconversion -- can be used to accomplish this end. The first two processes are, in principle, the same as those that can be used to change coal into synthetic oil and gas. Bioconversion relies on digestion of waste materials by bacteria. Methane, which can be burned as a fuel, is a product of the digestion. The technology needed for the use

of solid waste for fuel production is far from perfect. Sorting and transport of solid waste materials can be complex and expensive, as can the treatments. Hydrogenation is expensive, handling of hydrogen is complex, and high pressures must be maintained. No pressure is needed for pyrolysis, but the end result of the process is a mixture of fuels that is hard to separate and market. Problems of sulfur emissions, polluted water, and disposal of the organic sludge produced by bioconversion have yet to be solved.

Wind

People have used wind as a power source for generations. Windmills are a common sight in some European countries, and, until recently, were used in the United States, especially in the Midwest. There are some who suggest that we should return to windmills for some fraction of our electricity needs. Problems here include high costs, unreliable weather (or changes in the weather actually caused by great numbers of windmills), and the visual pollution of perhaps miles of unsightly generators.

Ocean Thermal Gradients

Water at the ocean's surface, especially in the tropics, is considerably warmer than water at greater depths. A device has been suggested which would draw water from different depths, using the difference in temperature to drive a turbine for the generation of electricity. Such devices would probably be subject to corrosion from sea water. Many such power plants could change ocean temperatures, with outcomes as yet unknown. Even if these problems were solved, the distance across which the electricity would have to be transmitted could mean great losses. An experimental unit of this type was installed off the coast of Africa in 1956, but was shut down soon after because of mechanical failures.

Hydroelectric Power

The energy of falling water can be used to generate electricity. Unlike fossil fuels or nuclear fuels, the supply of moving water will not run out. Hydroelectric power is inexpensive and fairly clean, but natural ecosystems are destroyed when dams are built. Unfortunately, most of the plausible sites for hydroelectric plants in the United States have already been developed. These plants currently supply about four percent of the energy

Table 1. Facts about Energy Resources

Energy Source	Availability	State of Technology	Economics	Environmental and Health Considerations
Coal	Top grades almost gone; lower grades abundant	Well-developed	Relatively inexpensive	Strip mining; deep mining; air pollution
Oil	Limited	Well-developed	Increasing costs; reliance on importation	Air pollution
Natural gas	Rapidly diminishing	Well-developed	Costs rising	Cleanest burning fossil fuel
Nuclear	Abundant (compared to fossil fuels)	Efficiency less than predicted	Expensive	Radioactive wastes; possible accident or theft; water pollution
Geothermal	Experts disagree on extent of possible usable sites	Semi-developed	Plants are less expensive to build and operate than fossil fuel plants	Air, water, thermal pollution; possibly earthquakes
Solar	For all practical purposes, infinite	Semi-developed	Home units expensive to install, cheap to operate; solar cells expensive	Might cover many acres of land with solar collectors
Solid wastes	Abundant, but sorting and transport are problems	Semi-developed	Relatively costly	Air and water pollution; disposal of organic sludge
Wind	Varies geographically	Developed, but seldom applied	High cost	Esthetics; change in weather
Ocean thermal gradients	Limited	Poorly developed; corrosion and transmission problems	?	Change in ocean temperature
Hydroelectric	Near-capacity use in U.S., high potential in other countries	Well-developed	Relatively inexpensive	Natural ecosystems destroyed; others develop in their place
Tidal	Only usable in certain coastal locations	Developed, but not widely applied	More expensive than hydroelectric	Damming of bays

used in the United States. However, there is great potential for hydroelectric development in South America, Africa, and Southeast Asia.

Tidal Power

The gravitational pull of the moon causes tides. A bay that is filled and emptied at high and low tides can be dammed, and, much like a traditional hydroelectric plant, the force of the water can turn turbines and generate electricity. Only in a few places could the power of the tides be harnessed. The cost of a tidal plant is much greater than that of a regular hydroelectric plant.

Summary

In dealing with analyses of alternative energy sources, it is sometimes difficult to weigh facts and opinions, one against another. We must continually ask such questions as

How much does it cost?
Is it worth the cost?
Can the cost be reduced?
Does the technology look promising enough to attract investments?
What is the environmental impact?
Are there ways of lessening or eliminating environmental disruption?
How plentiful is the energy source?
How safe is its use?

Table 1 summarizes some of the facts about alternative energy sources. But the information presented is only the first step toward answering questions like those above. What more can *you* find out?

5. ENERGY USES

In Chapter 4, you read some basic information about our sources of energy. You learned that about 95 percent of our society's energy (excluding food energy) comes from fossil fuels -- oil, coal, and natural gas. In 1971, the United States used 63.2×10^{15} Btu of energy -- a figure that is rather meaningless until we realize that this amount is equivalent to about 14 horses continuously serving every man, woman, and child in this country every hour of every day. What are these "horses" doing for us?

About 18 percent of the "horses" (if you are willing to imagine 2.5 horses) do useful work in homes and businesses. Another 2.5 work in industry. One-half of one horse works at moving people and materials from place to place. This describes where we use our energy, but you may realize that we have accounted for only 5.5 horses. What are the other 8.5 horses doing all this time? Of the 14 horses serving every person continuously, fewer than half are doing useful work.

The answer to this problem is rooted in the physical laws of energy conversion (see Chapter 6, PHYSICAL LAWS). Whenever energy is changed from one form to another, some energy is "lost" -- primarily as heat energy that is dispersed into the environment, serving no useful purpose. Of course, heat energy in homes and schools in the winter does serve a useful purpose and is, therefore, not considered waste. As a result of this physical law -- and sometimes as a result of poor design of buildings and poor maintenance of equipment and machinery -- much of the energy we consume is lost. For example, 3.5 of the imaginary horses actually work on transportation, but three of them may be thought of as wasting their efforts. We lose more than two of the horses just in the generation and transmission of electricity; and nearly another three horses work night and day in homes, businesses, and industries accomplishing nothing.

Ironically, the form of energy that accounts for most of our waste is the same form that accounts for most of our useful work. That form is heat. In 1968, we used 11 percent of our energy for residential space heat and 6.9 percent for heating commercial buildings. Industry used 16.7 percent of the nation's total energy for process steam and 11.5

percent for direct heat. Cooking, water heating, clothes drying, refrigerating, and air conditioning in homes and businesses accounted for another 10.4 percent.

Given this overview of energy use in the United States, think for a moment about two energy use sectors -- home use and transportation -- that are likely to be most apparent in your daily life. In 1968, the residential sector used about 19 percent of the total energy consumed in the United States. Taking that proportion as 100 percent, the table below shows the major home uses. The "other" category in the table includes mostly small appliances. Separately, such appliances use little energy, but together they constitute a significant use of energy.

Table 1. Energy Use in U. S. Residences*

	Percent
Space heating	57.5
Water heating	14.9
Cooking	5.5
Refrigeration	6.0
Air conditioning	3.7
Clothes drying	1.7
Food freezing	1.9
Other	7.9
Total Home Use	100.0

*Source: Stanford Research Institute

Looking at transportation in terms of the major subcategories within the sector can also be revealing. Transportation consumes about 25 percent of the total energy used in this country each year. As most people would guess, automobiles and highway travel -- primarily cars and trucks -- are our greatest energy uses for transportation.

Table 2 suggests which modes of transportation use the most energy, but in addition, one must ask which transportation forms are least intensive (see Table 3). In other words, which modes move people or materials a given distance with the least energy expenditure?

Table 2. Energy Use for Transportation -- 1970*

	Percent	
Automobiles	55.0	
Trucks	20.0	
Buses	1.0	
Other (including motorcycles)	.48	
Total Highway Transportation		76.48
Airplaines	9.87	
Railroads (freight)	3.51	
Railroads (passenger)	.06	
Shipping (inland and coastal barges and ships)	4.84	
Fuel pipelines	5.24	
Total Transportation Use		100.00

*U.S. Dept. of Transportation, *Summary of National Transportation Statistics*. Washington, D. C.: U.S. Dept. of Transportation (December 1972).

Table 3. Transportation Energy Intensiveness, 1950-1970*

FREIGHT TRANSPORT	Btu of energy needed to move 1 ton of freight 1 mile
Airplane	42,000
Truck	2,800
Waterway	680
Railroad	670
Pipeline	450

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PASSENGER TRANSPORT	Btu of energy needed to move 1 passenger 1 mile
Airplane	8,400
Automobile (urban)	8,100
Mass transit (urban)	3,800
Automobile (intercity)	3,400
Railroad (intercity)	2,900
Bus (intercity)	1,600

*Eric Hirst, *Energy Intensiveness of Passenger and Freight Transport Modes, 1950-1970*, ORNL Report NSF-EP-44. Oak Ridge, Tennessee: Oak Ridge Natl. Lab. (April 1973).

Industry is another energy use sector that affects our daily lives, but its influences are often overlooked because we take them for granted. Nearly everything in your home has been manufactured or processed. The paper in this book and the ink for its printing are products of industry. Look around your classroom. What would be left if all industrial products suddenly disappeared? As was indicated earlier, the major energy uses for industry are for steam and direct heat. Here's a more detailed breakdown of industrial use.

Table 4. Energy Use in Industry -- 1968*

		Percent
Process steam		40
Direct heat		28
Electric drive		19
Feedstock		9
Electrolytic processes		3
Other	Less than	1
Total Industrial Energy Use		100

*Source: Stanford Research Institute

This brief look at industry provides an excellent opportunity for the consideration of the larger energy picture. So far in this chapter, you have read only about the United States. But you might wonder where this country stands in relation to the rest of the world. The graph in Figure 1 matches energy consumption against steel consumption for a number of countries. What conclusions can you draw from this graph? Would you expect other variables, such as income, housing, or pollution to result in a similar graph? What does this graph suggest about life styles in the United States as compared with the rest of the world?

Some people have suggested that, because the United States consumes more energy than any other country and because fossil fuel energy sources are rapidly diminishing, every person should attempt to conserve energy. There are, of course, differing opinions. Even those who do agree that energy conservation is necessary are sometimes at a loss to specify the best means. Sometimes the data needed for conservation decisions are in conflict. For example, some sources have maintained that self-cleaning ovens use tremendous amounts of energy and should not be used. Oven manufacturers, however, insist that because self-cleaning ovens are better

insulated they actually consume less energy. Can you think of some things you might do to try to determine which statement is more accurate?

Although only a few laws or policies are now in effect requiring energy conservation (e.g., Federal Housing Administration insulation requirements and national speed limits), it may be that more and more such laws will be enacted. Should such laws be made? What kinds of laws would you view as fair or unfair? Why?

In dealing with such questions, one must consider changes over time -- both those changes that have occurred in the past and those that may occur in the future. Between 1946 and 1968, the population of this country increased 43 percent. Yet, during that same period, motor fuel consumption doubled. The manufacture and use of plastics increased more than 1000 percent. Generation of electricity is six times greater now than it was then. Similar increases can be noted for synthetic organic chemicals, synthetic fabrics, pesticides and other materials -- all derived from fossil fuels. One must ask whether such enormous and rapid increases in fossil fuel use are either possible or desirable. Will we be forced to change the way we live? Must we give up materials and services we now take for granted? Or will alternative energy sources provide options for living then as we do now.

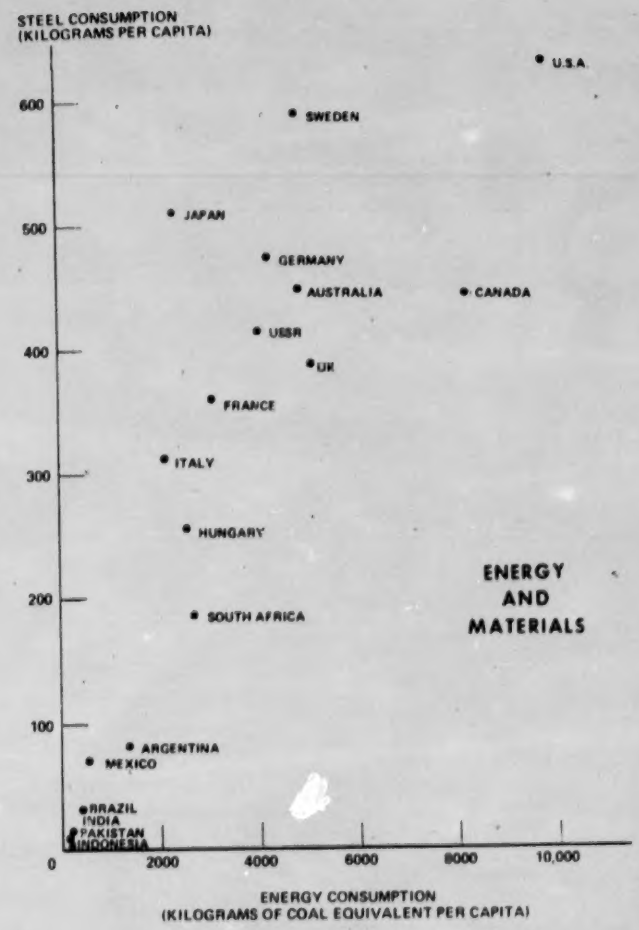

Figure 1. Energy Uses. (from D. S. Halacy, Jr. 1974. *The Energy Trap*, Four Winds, School Book Service)

6. PHYSICAL LAWS

Physical laws are those "rules of the game" that people cannot do anything about. Legislatures can declare rationing, tariffs, oil embargoes, solar energy research -- many different kinds of laws. But no one can legislate gravity, friction, or the creation of energy. The so-called "laws of nature" cannot be repealed or modified. No matter what energy question you investigate, you will encounter some physical laws along the way. You may find information about efficiencies, conversions, and transmission losses. What do these terms mean? What physical laws are operating? This chapter will help you get started in finding out something about the physical laws that govern energy conversions and uses.

Probably the first consideration is the basic question "What is energy?" This is a simple question that cannot be answered simply. The problem arises because energy is not a "real" thing. We cannot see, hear, taste, touch, or smell energy, although we can sense changes in matter that occur when energy is involved. We use the word energy more as an explanation for some things we see happening in the world than as a word to describe something tangible.

Physicists describe energy as the capacity to do work. Work, by the physicists' definition, is a force applied across some distance. The mathematics of physics makes this definition a useful one, but for most people, the definition doesn't say much about the physical world. In more practical terms, we know that energy is involved any time something moves, heats up, or cools down. So when studying energy, we look for motion and/or changes in temperature. Another important term that you may encounter is power. Power is not energy, but the *rate* at which energy is used or the rate at which work is done. Thus, the idea of power includes not only energy but time -- how fast energy is used.

Energy can be described in a variety of ways. For example, energy can be active (kinetic) or stored (potential). A storm accumulates potential energy from forces in the atmosphere. Under certain conditions, that energy is released kinetically in the form of a flash of lightning. A large boulder resting on the edge of a cliff has, by reason of its mass

and the pull of gravity, a large share of potential energy which would be released if the edge of the cliff were to crumble. The boulder crashing down the cliff side to its next resting place releases kinetic energy. Gasoline in the storage tank is a highly explosive source of potential energy. A small spark will set that energy in motion. The consequence, of course, depends on where and how the spark is applied.

Energy may be stored and released in different forms: for example,

- *light*, such as from light bulbs or the sun;
- *heat*, such as from a wood fire, a steam radiator or an electric heater;
- *electricity*, such as is stored in batteries or released through electric wires to appliances in the home;
- *mechanical energy*, such as the force applied by the gears that turn the wheels of an automobile, or the potential mechanical energy stored in the coils of a spring;
- *chemical energy*, such as that in gasoline or in the head of a match;
- *nuclear energy*, such as that emitted from radioactive particles released from atomic explosions.

Energy can be transferred from one source to another and changed from one form to another. Examples of this process are:

- Light energy from the sun is transformed through food-making processes in green plants to stored chemical energy, such as in the juice of an orange or in a blade of grass. The energy that is trapped in plants is transferred to animals through the food chain.
- Heat energy from burning gas or coal can be used to produce steam. Steam under pressure releases enough force to turn the wheels of a turbine generator to produce electrical energy. Electricity can, in turn, be transformed by the coils of an electric heater into heat energy.

Energy is conserved. This statement is known as the First Law of Thermodynamics. The law means, simply, that the total energy present in the universe never changes. There is no evidence that energy can be created or destroyed. It can only be changed in form or transferred from one place to another.

Energy conversions are less than totally efficient. This principle is derived from the Second Law of Thermodynamics. Energy conversions are inefficient because some heat is always generated. The heat is considered

lost when it does no useful work. The total energy in the system and in the universe is still the same. No energy is destroyed. But heat energy is dispelled randomly into the environment and is, for all practical purposes, lost. A good example here is pushing a box across the floor. Some of the energy you exert actually moves the box. But, because of friction, some of the energy is lost to heat on the surface where the box and the floor touch. Thus, the conversion of your energy to kinetic energy in moving the box is less than 100 percent efficient.

Energy is not always readily available for human use. Humans generally consume forms of energy that are readily available and easy to use. Heat lost from energy transfers, as in burning coal to produce steam, is scattered in the atmosphere. With the possible exception of the heat pump, we have developed no way of recovering and using the heat lost to the atmosphere.

Energy is measured in many ways. Don't let all the units of measure confuse you. You can make meaningful (and sometimes humorous) comparisons among energy sources simply by converting all your information to the same unit. Here are some definitions, abbreviations, and conversion factors that may help.

Definitions

British thermal unit (Btu). One Btu is the energy required to increase the temperature of one pound of water 1°F. For example, it takes 300 Btu to heat one quart of tap water to boiling. How is that figured? One quart weighs two pounds. Assume tap water temperature is 62°F. Boiling point is 212°F, so the necessary temperature rise is 150°F. Two pounds times 150°F equals 300 Btu.

Calorie. One calorie is the energy required to raise one gram of water 1°C. A kilocalorie or Calorie (with a capital C) is 1000 calories.

Kilowatt (1000 watts). A unit of electrical power indicating the rate at which electrical energy is being produced or consumed.

Kilowatt-hour (1000 watt-hours). A unit of electrical energy equal to the energy delivered by the flow of one kilowatt of electrical power for one hour. For example, a 100-watt bulb burning for ten hours will consume one kilowatt-hour of energy.

Abbreviations

bbl	--	barrel (contains 42 gallons)
kw	--	kilowatt
kwh	--	kilowatt-hour
Mcf	--	1000 cubic feet (of gas)
mw	--	megawatt, 1 million watts
Btu	--	British thermal unit
therm	--	a unit of energy used for natural gas equal to 100,000 Btu
kcal or Cal	--	1000 calories

Conversions Factors

To convert from	To	Multiply by
kilowatt-hour	Btu	3,412.8
ton bituminous coal	Btu	26,200,000
bbl crude oil	Btu	5,600,000
bbl residual oil (No. 5)	Btu	6,290,000
gallon gasoline	Btu	125,000
gallon No. 2 fuel oil	Btu	138,800
cubic foot natural gas	Btu	1,031
Mcf natural gas	Btu	1,031,000
therm natural gas	Btu	100,000
gram calories	Btu	.00397
kilogram calories	Btu	3.97
cubic ft. atmospheres	Btu	2.721
foot pounds	Btu	.001284
horsepower hours	Btu	2,546.14
horsepower years	Btu	22,304,186.4
Langleys	Btu/sq. ft.	3.69
Btu	cubic centimeter atmospheres	10,405.6
Btu	cubic foot atmospheres	.36747
Btu	foot pounds	777.694
horsepower	ft.lb./sec.	550
horsepower	ft.lb./min	33,000

To convert from	To	Multiply by
horsepower	ft.lb./hour	1,980,000
Btu	gram calories	251.9958
Btu	kilogram calories	.2519958
Btu	horsepower hours	.0003927
kilowatts	horsepower	1.34124
horsepower	kilowatts	.7547
horsepower	watts	754.7
Btu/sq. ft.	Langleys	.271
Btu	kilowatt-hours	.000293

From this table one can determine that the 660 kilocalories in a quart of milk are equivalent to 2640 Btu. Since there are 31,250 Btu in a quart of gasoline, you'd have to drink about 12 quarts of milk to get as much energy as your car gets from a quart of gasoline.

Simple Calculations with Large Numbers

Very often you will see energy expressed in exponential form -- e.g., 10^6 Btu. This is a convenient way of expressing large numbers such as millions, billions, or even quadrillions involved in measuring energy, instead of using many zeros. It is a formula which indicates the multiples of 10 used to arrive at large numbers. For example:

$$1000 = 10 \times 10 \times 10 = 10^3$$

$$1{,}000{,}000 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 10^6$$

The simplest way to use this system is to remember that the exponent tells you how many zeros the number will have,

$$10^4 = 10{,}000 \text{ (4 zeros)}$$

or, in the case of decimals, how many places to the right to move the decimal point,

$$2.5 \times 10^4 = 25{,}000 \text{ (decimal moved 4 places to the right)}$$

Exponential numbers are easy to add and subtract after all the numbers have been converted to the same exponent. To do this, you may move the decimal point to the *right* and *subtract* the number of places moved *from* the exponent *or* move the decimal point to the *left* and *add* the number of places

moved to the exponent. For example,

$2.5 \times 10^5 = 250.0 \times 10^3$

$2.5 \times 10^2 = 0.25 \times 10^3$

Examples of addition:

$10^3 + 10^3 = (1 \times 10^3) + (1 \times 10^3) = 2 \times 10^3$

$(2.5 \times 10^4) + (2.5 \times 10^4) = 5.0 \times 10^4$

$(2.5 \times 10^4) + (2.5 \times 10^3) = (25.0 \times 10^3) + (2.5 \times 10^3)$

$= 27.2 \times 10^3$, or 2.72×10^4

Examples of subtraction:

$10^4 - 10^2 = (1 \times 10^4) - (.01 \times 10^4) = 0.99 \times 10^4$, or 9.9×10^3

$(2.5 \times 10^4) - (1.0 \times 10^4) = 1.5 \times 10^4$

$(2.5 \times 10^4) - (1.0 \times 10^3) = (2.5 \times 10^4) - (0.1 \times 10^4) = 2.4 \times 10^4$

To multiply, multiply the first numbers in each expression, then add the exponents of the second numbers.

$10^5 \times 10^7 = (1 \times 10^5) \times (1 \times 10^7) = 1 \times 10^{12}$, or 10^{12}

$(2.5 \times 10^4) \times (2.0 \times 10^4) = 5.0 \times 10^8$

To divide, divide the first numbers, then subtract the exponents.

$10^9 \div 10^6 = (1 \times 10^9) \div (1 \times 10^6) = 1 \times 10^3$, or 10^3

$(2.5 \times 10^4) \div (1.0 \times 10^2) = 2.5 \times 10^2$

7. POLITICS AND THE LAW

There is a great deal that one can know about how politics and the law work together in our country, but only a small part of that knowledge can be included here. No investigation of energy decision making can escape the issue of *public policy*, and it is in this area that politics and the law operate.

What Is Public Policy?

Public policy is established by the law and/or by tradition. It is the set of laws or directives under which public institutions and agencies define their roles and administer public services. Governments are established to organize and manage social systems. The effort that is involved in accomplishing this is described as *politics*, and the written rules by which the social systems work are called laws or statutes. In local governments, such as in cities or townships, the term *ordinance* is frequently used instead of law. These statutes, laws, or ordinances define the functions, rights, powers, and restrictions that govern the way the society operates. In a democracy, such as the United States, these "rules of operation" are derived from an agreement by the people to allow themselves to be governed by law -- an agreement that is specifically described in our Constitution.

Law and the Constitution

The Constitution of the United States represents and expresses the consent of the people of the several states to be governed as a group by a central authority, the federal government. The Constitution specifies the structure and the powers of the federal government and establishes the functions of laws. It specifically reserves certain powers to the states; and further, it defines the "inalienable rights" of individual citizens which cannot be taken away by any action of the government, whether at the national, state, or local level.

State laws may not be passed in defiance of constitutional limitations; nor can local officials enact ordinances that are not in accord with federal or state laws. It is important to remember, however, that the Constitution can be, and has been, changed or amended by procedures involving all of the states. When the Constitution does not serve the best

interests of the people, the people themselves have the power to change it. The same principle applies to federal, state, and local laws. These statutes represent public policy. Once public policy is established, each citizen must act in accordance with the law or, alternatively, work toward changing or repealing the law.

Politics and the Legislatures

Legislatures establish laws in accordance with the Constitution and the wishes of the people. Legislative bodies exist at the federal, state, and local levels. The national legislature, or Congress, enacts federal laws. These laws generally control relations between states and define constitutional limits on actions that any state may take in controlling its own internal affairs.

Legislators and potential legislators form a major group of people defined as *politicians*. Their primary role is to enact laws that establish public policy, and they are usually chosen as a result of political activity. Political parties are organized to support candidates for public office and to promote particular points of view on issues of public policy. Thus, political groups provide voters with information about policy alternatives and about political candidates.

Political activity extends through all levels of government, from local to national. Since our government is a government of laws, the women and men elected by the people to make laws must attempt to express the wishes and desires of the people who voted for them. If they do not, they may not be re-elected once their terms of office expire.

The Executive Branch of Government

The Constitution establishes an executive branch of the government to carry out public policy as expressed in the laws. The President is the executive officer with sole responsibility for administration of public policy in accordance with the law. Individual states have a similar executive officer -- the governor. Even though the power and authority for administration is vested in a single executive officer, presidents and governors oversee a vast network of agencies that assist in administrative functions. The President or Governor appoints the heads of these agencies and delegates authority to them. Most other government employees are

professional or technical civil service workers who implement, rather than make, policy decisions.

In national policy questions, the President has specific responsibilities delegated by the Constitution, especially in foreign and military affairs. Nevertheless, all presidential actions must be in accordance with the law, either as it is expressed in the Constitution or as expressed in laws established by Congress. Because of the President's great responsibility for management of the nation's affairs, he or she frequently uses the powers of office to persuade Congress that certain laws are needed. If Congress does not agree, the President may take the appeal directly to the people.

The President may use power and influence in other ways as well. The President can make decisions that will favor one group or individual over another. If the chief executive is popular, gaining presidential favor may mean the difference between success and failure in politics. Favors are very often traded among politicians in order to maintain political advantage. The making of political decisions is almost always a matter of reaching a compromise between different points of view, and the exchange of support and influence is considered the "legal tender" of political activity, just as money is the legal tender of commercial and economic activity.

The Courts and the Judicial System

The third branch of government established by the Constitution is the judicial branch. This branch, composed of judges and courts, has powers that are intended to balance and control those of the Congress and the President. The federal court system interprets the federal laws and the Constitution and sees to it that laws are justly established and administered. In matters of controversy involving the constitutionality of laws passed by the Congress, or actions taken by the President, the federal courts have the final say about who is right. The power of the court extends to controversies between any and all other persons when federal laws are in question. A complex system composed of district and circuit courts and a Supreme Court makes access to federal jurisdiction possible for citizens throughout the country.

State court systems are organized in similar ways to deal with state

laws. In matters where state courts have clear jurisdiction, final decisions may rest with the state Supreme Court. In all cases, however, judgments of state courts may be subject to review and reversal by federal courts if rights under the Constitution or federal laws have been violated. This system of appeals to higher courts is one of the most valuable protections available to citizens of this country. The Supreme Court of the United States is, of course, the court of final appeal.

The freedom of the courts from political pressure is one of the strengths of the federal judicial system. Federal judges are appointed for life and can only be removed by the Congress. While they are appointed by the President, approval of the Senate is required before a judge may be "seated." Once seated, the judge's decisions are subject to review only by his legal peers in courts of higher authority. It is unlikely that any judge would be removed from office without strong condemnation from the legal profession supported by judges of equal or higher rank.

While there may be minor variations among the states, the pattern established by the federal judiciary extends to the structure of the state court systems. This similarity helps to protect citizens in a free and open society from the confusion of conflicting and dissimilar legal systems.

Influencing Changes in Public Policy

Changing public policy, or writing new laws, is a complex task requiring the wisdom of many people. Nevertheless, each year brings many such changes. When people are dissatisfied with the services that the government provides, they express themselves through the political system in an effort to bring about change. Where one goes to influence change depends on whether state or federal law is involved. In either case, members of the appropriate legislative body must be persuaded to make the desired changes. This persuasion may take the form of pressure brought to bear by public opinion, by special interest groups or lobbies, by the executive branch, or by combinations of these. Public opinion may be expressed through the news media, through opinion polls, or through public displays such as letter writing campaigns or protest marches.

Legislators are very sensitive to the opinions expressed by the people

who elect them to office and will usually try to represent the will of the majority of their constituents. There are, however, cases in which the interests of the entire nation may appear to be more important than the wishes of a local group. In such cases, a sincere and honest legislator may take it upon himself to try to persuade his constituency to take a different view of the matter.

Many special interest groups have been organized to influence legislation. These groups may hire professional lobbyists and maintain offices close to the seat of government. Their legal function is to provide legislators with information that will influence them to vote in favor of the interests of the group. Some of the largest lobbies are maintained by business and industry, the professions, and labor unions. Other, smaller, but no less important groups include consumer groups, ethnic groups, environmental groups, and the like. On occasion, some of these groups have gone beyond legal limits in their attempts to influence legislative votes. By contributing large sums to election campaigns, larger and more powerful groups may exert an unfair amount of influence on the outcome of elections. Laws designed to control this kind of influence have had great difficulty gaining congressional approval. Such lobbies are required to register and are subjected to periodic reviews of their activities to assure that they act within limits prescribed by law.

Each citizen in a democracy has some means of influencing public policy. For some, the influence may be limited to a single vote; others extend and enlarge their power by joining and supporting political parties or special interest groups that share their points of view on policy questions. Still others choose to run for public office in an effort to advance a cause or represent a political position or group. Whatever the level of involvement, the political system in the United States "belongs" to the people. Whether individuals use the system effectively is a matter of personal choice.

Investigating Questions of Public Policy

You should now be able to recognize the societal components that are involved in making public policy decisions and how politics and the law are intertwined in this process. You should know also that each citizen

has certain rights of access to information about public policy. This access is usually described as the "public record." Such records are maintained by all governmental bodies and are available for inspection. Limitations on this access are usually also defined by law. Some limitations involve certain kinds of information that can be classified as "secret" (as in the case of national security information) or "private" (such as personal income tax returns of citizens). Other limitations simply maintain orderly access to the records, protect the documents from vandalism, or help defray the cost of making materials available. In any case, information on public policy and legal questions is readily available from a large variety of sources. These include

The Statutes (written records of laws passed at local, state, and national levels)

The Congressional Record

Court Records

Agency Files and Publications (Government Printing Office)

The Library of Congress

Legislators

Lawyers, Courts, and Judges

Officers of Political Parties

Members of Political Parties

Lobby Headquarters Offices

Federal and State Agencies Directly Involved with Energy Policy Questions

Atomic Energy Commission

Environmental Protection Agency

State Energy Control Boards

Environmental Quality Council

and others

8. ENVIRONMENTAL IMPACT

Every organism -- or group of organisms -- has some effect on its environment. The individual or group, is, in turn, affected by the environment. In addition, living things, both plants and animals, influence each other. These universal interactions are the subject of the science of ecology. Ecologists study the interrelationships of living organisms with one another and with the physical environment. In order to undertake such a study, the ecologist must carefully define a particular unit for research, setting limits on what will be considered. This unit is termed an *ecosystem* and may be as small as a vial of bacteria or as large as the entire planet. But to make any such study manageable, the researcher must limit the number of factors or variables to be considered, in order to construct a simplified, coherent model of some complex reality. Subsequent studies may require increased detail; more variables will be considered; and the model will more closely approximate the reality.

This chapter describes some of the things you may see in natural ecosystems, as well as in systems that are man-made or are greatly affected by man. Every organism modifies its environment, but perhaps no species has had a greater impact on the environment than man. There are few areas of land or sea that have not been affected, directly or indirectly, by human activity. For this module, we must ask questions about the nature and extent of the impact of our use of energy on the environment.

What Processes Are at Work in Natural Ecosystems?

A natural system is one in which humans are not the major, overriding influence. Although people may be part of a natural system, their effect is not the dominant factor to consider, as it may be in an urban or agricultural system. Thus, we may choose to study a pond, a forest, or a prairie as a "natural" ecosystem. What forces are at work in such areas?

First, interaction is always occurring. Populations of organisms are affecting, and are being affected by, the nonliving environment. Individual organisms and populations of organisms also interact with each other. In a forest, for example, trees shade the forest floor, producing

a change in the moisture and temperature of the soil. Trees provide homes for birds, squirrels, beetles, and insects. The food-making activities of green plants in the forest constitute the base of the food web in the forest ecosystem. The growth of plants takes minerals from the soil, minerals that are returned to the soil with excreted wastes and decomposing plants and animals. This example of materials being taken from and returned to the soil suggests another natural law that operates in all ecosystems. Materials are cycled. Although the form of materials may change, nothing is ever destroyed. Rather, materials pass back and forth between the living and nonliving components of the ecosystem.

Unlike materials, energy does not cycle. It "flows." The original source of energy for any ecosystem is the sun, although a few ecosystems, such as caves, receive the sun's energy indirectly. Some of the solar energy is captured through photosynthesis by green plants. The remaining radiation is absorbed by the earth, reflected back into space, or dispersed randomly in the environment as heat. The energy that is stored as chemical energy in the green plant is the "fuel" for the operation and growth of the system. The energy may remain stored in plant tissues or may be expended as the plant respires, grows, and reproduces.

Animals that feed on plants obtain energy from their food. Some of that energy is stored in animal tissues, while the rest is used up in metabolism and activity by the animal. Storage and use of energy continues along the food chain. Much of the energy flowing through an ecosystem is quickly released into the environment as heat. Even the energy stored in plant and animal tissues is eventually released as heat -- although the storage may, as in the case of fossil fuels, continue for millions of years. The point is that all energy in the system, is, sooner or later, randomly dispersed in the environment as heat -- a form that cannot be recaptured and reused by living organisms. An ecosystem must continually receive new supplies of energy from the sun or it will not survive.

In a natural ecosystem, interactions among living and nonliving elements of the system are balanced. Balance does not mean that every interaction is exactly the same at all times. Balance, in this sense, describes a state that may be thought of as dynamic equilibrium, where slight

fluctuations from the norm may occur. For example, photosynthetic rates may vary with season, temperature, and available moisture. Numbers of squirrels or insects in a forest ecosystem may vary. But the system is "self-adjusting"; no single element or interaction changes enough to change the system as a whole.

Thus, when one considers environmental impact, one must consider the *magnitude* of the impact. Again, using the forest example, assume that a population of 100 squirrels can be supported by five acres of forest. A population of 105 or 95 squirrels probably would not make much difference in the balance of the total ecosystem. If, however, a change in some factor were to cause the squirrel population to double or triple, the squirrels might then place too great a load on the food-making and habitat capabilities of the forest. The destruction of plants and physical environment could result. This would be a system "out of balance."

What are some of the factors that can influence the balance or imbalance of a natural ecosystem? The following list includes only a few of the most obvious ideas for a land system. Some elements would be different, of course, for a freshwater or ocean system.

Air quality, water quality, physical characteristics of soil.

Slope, drainage, weather (precipitation, droughts, cloudiness, winds, etc.)

Rocks or rock slides, soil chemistry.

Kinds of plants, sizes of plant populations, kinds of animals, numbers of animals.

Reproductive behaviors and physiology, immigration and emigration of plant and animal species.

Animal excretion and respiration, diseases of plants and animals.

Numerous animal behaviors other than reproductive, biochemical activity of soil microorganisms, etc.

Any discussion of balance must take into account one other phenomenon often encountered. This is the concept of synergism (SIN·ur·jism), "the simultaneous action of separate agencies which, together, have greater total effect than the sum of their individual effects." In other words, the whole is greater than the sum of its parts. The classic example of this principle lies with the action of drugs. Alcohol alone and tranquilizers alone have certain effects on the body. But alcohol and certain

tranquilizers *together* can constitute a deadly combination. This principle of synergism also operates in the environment. Fish can, for instance, tolerate certain levels of lead in water at a certain temperature. But, at higher temperatures, previously safe levels of lead can become lethal.

Ecosystems Dominated by Human Activity

Principles of interaction, equilibrium, and synergism apply as surely to systems that are made or dominated by human beings as they do to natural systems. In the construction or maintenance of cities, highways, factories, or power plants, the question of impact on the environment becomes an overriding one. One must determine how much change the physical environment, and the organisms that depend upon that environment, can tolerate without enormous and irreparable disruption. Due to the nature of interaction between organisms and the physical environment, such disruptions could "backfire" on the human population. There is evidence to support the idea that human activities have already caused serious, and perhaps irreversible, environmental damage in certain areas. Some rivers and lakes are so polluted that fish can no longer inhabit them. Some animal species have become extinct or face extinction as a result of destroyed habitats, hunting, or chemical modification of the environment.

This last example leads to an important lesson concerning the impact of human activities. A noted biologist puts it this way: YOU CAN'T DO JUST ONE THING. For years, DDT was used to control insects in agricultural areas. But that one act had an effect that was neither desired nor anticipated. The pesticide became concentrated at higher levels in the food chain, with the result that pelicans received large doses of DDT. The eggshells produced by these pelicans were thin and broke easily. For a while, it was thought that the brown pelican might become extinct. Now that DDT is no longer used extensively in this country, the pelican population may have a chance to recover.

Those who make decisions about human activities must always expect the unexpected. It is probable that doing one thing will lead to many other things -- things that should not be left to chance.

Given the idea that every action has more than one outcome, the decision-making process must often involve an analysis of trade-offs. What are we willing to sacrifice in one area in order to gain something in another area? Should we give up wilderness regions in order to put more land into food production? How clean does society want its air and water to be? Are people willing to give up clean air in order to gain more electricity or greater economy in transportation? How much environmental disruption is acceptable in the search for new energy sources?

The answers to all these questions depend on judgments of positive or negative impacts on human interactions with other living things and with the physical world. The problem that must be considered is how much the environmental impact of any human activity affects quality of life. In fact, do some decisions affect not only quality of life, but actual chances of survival for the human population? No matter what energy questions you have decided to work on, you are sure to encounter these kinds of concerns during the course of your investigation.

9. ECONOMICS: PUBLIC AND PRIVATE

What is the Economy?

The economy, or economic system, is made up of recognizable elements that involve every man, woman, and child in our country and elsewhere. The most familiar of those elements are the goods and services that are required to satisfy our basic needs and wants. The flow of these goods and services is generated by our demand for them, and by our willingness to exchange something that *someone else* wants or needs for the things *we* want and need.

The economy functions through the flow of money or negotiable securities. These are accepted by everyone in the society in exchange for goods or services. Money can be held while the holder makes some choices about when, how, and where he or she wishes to make exchanges (purchases). The inability of every individual to satisfy all of his needs and wants through his own direct and independent effort has made this pattern of exchange -- or trade -- a universal social phenomenon. Therefore, today, there is no level of human activity that does not in some way require some trading in the economy.

Gross National Product (GNP)

In this country, perhaps more than any other, the number of things that people want, or feel that they need, has been enlarged by creative technology and massive advertising. As a nation, our industrial productivity has placed many time and effort saving products within reach of most of the people. The complex and varied lines of supply of raw materials to feed this massive technology depend on trade, just as does the distribution of the finished product. In other words, this creative productivity not only provides things that people want, but it provides them the opportunity to trade their labor for the money with which to purchase products in the economy. This circular-sounding pattern accounts, in large part, for the extremely high standard of living that this country has enjoyed, compared with much of the rest of the world. The sum total of all production of goods and services in a specified period of time is called the Gross National Product (GNP). For many years, the United States has been the world's leader in Gross National Product, and the total productivity of any nation has been judged a measure of its prosperity and stability. However, this high level

of productivity also accounts for some scarcity of resources needed to "fuel" the ever-hungry economic machinery.

Supply and Demand

Just as it is impossible to determine where a perfect circle begins, so too it is difficult to say where the interlocking mechanisms of the economy begin. However, since we began by discussing needs and wants, let us continue to treat them as beginnings. If we could identify the first time that a person ever wanted something that he *did not* have and offered to trade something that he *did* have for it, we would have identified the beginnings of the economic system. The industrial revolution that transformed the world from an agricultural to a technological one served to increase the number and variety of things that could be wanted. The degree to which things are wanted, in proportion to their availability, expresses the relationship of demand to supply. When a large supply of something is available in the marketplace and there are few people who want it, the price of that commodity will be very low; i.e., the price must be established at a level that creates a desire to trade for it. On the other hand, if this same product is modified in such a way as to make it more attractive to a larger number of traders -- even by lowering the price still more -- the demand for the product may rise to such a level that the supply is severely reduced. When the supply is reduced to a level where it is insufficient to meet the demand, or when the demand is so great that traders are willing to pay a higher price, the price will rise in response to that demand. This process tends to channel particular goods toward those who are willing to pay most for them and, at the same time, to encourage industry to produce or provide those things for which there is the greatest demand.

The Private Enterprise System and Profit

Much of the economy of the United States is founded on private enterprise; i.e., the willingness of individuals or corporations to risk their financial holdings (capital) on possible profit-making ventures. The element of risk rests with the possibility that buyers in the marketplace may or may not want the product enough to create a demand; and that the demand may or may not be sufficient to establish prices high enough to absorb production costs and provide a margin of profit on the dollars invested. The degree to which businesses are successful in creating a demand will determine not only their

profit, but their ability to purchase supplies and to pay their employees at an agreeable level. This complex relationship between willingness to invest capital in production and the ability to create demand, pay wages, maintain production and realize profits is the basis for the economic system. When government involvement and control of the process is minimized, the system becomes one of free and private enterprise, controlled primarily by the responses of the marketplace.

Governmental Controls on the Economy

The alternative to a free economy is a controlled economy. The responsibility for control usually resides in government, whether in a democracy or in a totalitarian state. In either case, governmental control must strip the marketplace of its primary risk incentives and replace these with decisions about what is best for all concerned. Even in a free and democratic society, there are those areas of fundamental need in which the public interest is best served by control of certain commodities in the marketplace. For example, food, housing, transportation, and fuels are considered necessities in the United States economy. Maintaining supplies at levels adequate to demand cannot be left to chance; nor can prices of these necessities be allowed to fluctuate to such a degree that only the wealthy can afford them, or that those who produce them are unable to remain in business because periods of over-supply force prices too low. These instances call for a governmental response which may take the form of government subsidies (payments to producers) to keep production at profit-making levels, or welfare payments to the poor to assist them in obtaining housing, food, and other necessities. Maintaining a reasonable balance between control and free response in the economy is one of the great challenges to a democratic government.

Economists, politicians, and business people often disagree on how much governmental involvement in the economy is necessary or desirable. It should be noted, however, that the larger and more complex an industrial/technological society becomes, the more likely it is that governmental supervision and/or participation in the economy will be required. A large number of governmental departments, councils, and agencies are involved in observing and responding to economic trends in the United States. From the Treasury Department to the Internal Revenue Service, citizens and

institutions can be held accountable for their financial behavior. A partial list of government offices that might be involved includes the President's Council of Economic Advisors, Federal Trade Commission, Securities and Exchange Commission, Federal Deposit Insurance Corporation, Federal Aviation Administration, Federal Communications Commission, Agriculture Department, Bureau of Reclamation, Departments of Labor, Commerce, and Transportation, Department of Health, Education, and Welfare, the Food and Drug Administration, Atomic Energy Commission, Environmental Protectional Agency, Public Health Service, Fish and Wildlife Service and many more. Each of these has some level of responsibility for "watch-dogging" marketplace activities and recommending action to the President or the Congress, or for enforcing regulations on various segments of the economy.

Another area in which government affects the economy is through direct participation in marketplace activity. Through taxation, the government acquires capital which it places in the economy in selective ways for specific purposes. Because of this activity, the government is able to control supply and demand in a variety of ways and for a variety of reasons. The government may issue contracts to corporations for defense equipment and supplies and, in time of war, become the nation's largest consumer of manufactured products. By providing grants to certain groups, the government can encourage the initiation of research and development activity in the hope that new technologies or methodologies can be developed to serve a specific public or governmental need. We have already mentioned business subsidies and welfare as somewhat similar means of supporting segments of the population that cannot afford to respond to normal marketplace activity.

Distortions in the Economy: Inflation, Recession, Depression

Fluctuations occur constantly in the economy. In normal circumstances, these fluctuations are small and variable, i.e., up and down with respect to prices. When, however, there is a significant general rise in demand for goods and services that strains the ability of the economy to provide them, prices will show a marked "inflationary," upward spiral. Such a trend occurs generally when the prevailing mood of the marketplace is optimistic -- sensing that there is, or will be, an increase in the amount of money available to purchase goods and services at higher prices. Investors will support the development of huge inventories, and banks will extend large amounts of credit. Consumers

venture heavily into credit buying and the economy is pictured as a "boom" economy. The almost inevitable result is a shortage of money or resources that pushes the cost of production and of borrowing to ever higher levels until a saturation point is reached that forces the economy to react negatively. Buyers find prices too high and refuse to buy, causing a sharp drop in marketplace activity. Businesses are caught with large inventories of expensive products. Pessimism sets in as business finds itself facing losses instead of profits, and production cutback results in unemployment which strains social service agencies beyond their capacity. Financial institutions are affected by the lack of activity, and a recession sets in. When such conditions become severe, and normal recovery processes are no longer possible, the economy is in depression.

The usual source of control of such drastic distortions in the economy is derived from governmental participation. In theory, the government can ward off such dangerous variations by regulating the flow of capital through adjustments in taxes, interest rates, public employment projects, and similar activity. In practice, however, the moods of the marketplace do not always respond readily to governmental intervention.

International Trade: Imports and Exports

Import and export activities have always been major forces in the economy. Other countries have provided a ready market for United States technological know-how. At the same time, cheap labor abroad has encouraged United States businessmen to purchase certain scarce commodities and materials from abroad for use in local business and industry. In some cases, they establish factories overseas to reduce production costs still more and increase profit margins on their investments. Increasing sophistication of less developed countries in recent years has brought such activity to what might be termed a "grinding halt." Some foreign governments have come to recognize the high cost of American products compared with the low prices that are paid for their goods and services. "Cheap labor" countries have moved toward more control of their own resources for their own welfare. By raising prices on their resources, such as oil and gas, they have forced prices on these commodities in the United States markets to go steadily upward, adding to already severe inflationary pressures. At the same time, their willingness to pay high prices for badly needed United States food products has caused

farmers in this country to offer their produce to the highest bidder, thereby raising costs to local markets. These examples merely illustrate the complex set of circumstances that contribute to instability in the economy and provide trouble for the marketplace.

Energy and the Economy

As you explore various aspects of your energy-related problem or question, it should help you to know how the economic system is involved and how such involvements affect decision making. Whatever the topic of your investigation, you should be able to use the information above as you attempt to answer questions of supply, demand, cost relationships, and the alternative courses of action available within the economic structure.

10. ATTITUDES AND FEELINGS

Solving problems related to the many issues involving energy use is not a small task. Many energy use decisions are based on how people feel rather than on hard facts. Even when hard facts are used, differing points of view gained through past personal experiences affect decisions. Two people given the same basic information may come up with opposing answers to the same problem. Thus, attitudes and feelings must be taken into account when we are looking for ways to resolve energy-related issues.

Opinions and Situations

The question of whether to ration gasoline is a good example of how feelings and attitudes affect personal opinions on problems. A person with a big car, a long way to drive to work, and plenty of money favors high prices or taxes on gasoline because high prices would discourage gasoline use. A second person with less money and a small car, who can walk to work, may be in favor of rationing and keeping prices low. He or she might say, "If gas is rationed, everyone can get a reasonable share of what's available, and I can save my coupons for Sunday drives in the country and for a summer vacation." It is clear that the attitudes and feelings of these hypothetical individuals are affected by their circumstances. Given the same facts about gasoline shortages and a chance to vote on rationing, they probably would take opposite positions because of their individual situations.

Many similar conflicts and arguments can be imagined. How do you think people who depend on coal mining for a living would feel if Congress proposed legislation to ban the use of coal in producing electric power? Some people, thinking about air pollution in major cities, might be happy to see coal consumption drop; but it is doubtful that a coal miner would see it the same way.

Vested interests with emotional and attitudinal ties also influence decision making. One would hardly expect an association of automobile manufacturers to support laws that severely reduce the use of cars. A religious group that opposes the use of modern conveniences will look at energy use issues very differently than an international socialite.

Attitude Formation

Taking a harder look at how attitudes and feelings are formed, we find that parents and peers are important. Everyday living with parents results in the transmission of attitudes, even though the child is probably unaware of the transfer. Have you ever caught yourself expressing an opinion without really knowing why? Perhaps, later, you realized you got the idea from a parent or some other adult in an earlier conversation. Do you have some preferences or habits that are the same as your parents'? For instance, suppose your father made a point of turning off lights when leaving the room. Might you have picked up the habit? What other examples can you think of in which your parents' attitudes might affect your behavior.

Our friends also influence us strongly, especially as we grow older and depend less on parental care and guidance. It is not unusual for groups of teenagers and young adults to favor one political candidate, while the majority of elderly voters favor another. Each generation seems to develop and adopt a set of social values that is in some ways different from the ideas of the previous generation or of the one that will follow. An even more obvious example is fashion or fad. Changing social climates result in frequently changing preferences for styles or possessions. For high school boys in the 1950s, a motor scooter was a supreme status symbol. Cars and motorcycles seem to serve that function today. Can you think of other fads or fashions that relate to our attitudes about energy use?

Cultural standards also affect the way we look at energy use. In India, where most young adults stay very close to their home villages, even a bicycle is not considered a necessity. Walking or getting around by oxcart or a one-horse tonga provides adequate transportation. Energy use in rural Indian culture is very low. What cultural differences in the United States affect energy consumption? Are there some segments of our society that use more energy than others? Do people living in the heart of our major cities have different attitudes about energy than people living in suburban areas or on farms? Why?

Changing Attitudes

Can attitudes and feelings be changed? If so, how? Consider the following conversation:

Ralph: I hope I can get a good job this summer so I can buy a new set of wheels.

Tom: Me, too. That piece of junk I've got gets me nowhere.

Judy: I'm hoping to get a good job, but I want to sell the car my mom and dad gave me so that I can put the money in the bank.

Tom: Why?

Judy: I want to go to Community College next year and I'll need the money. Besides, I think I can get along riding the bus.

Tom: I'm hoping to go to trade school next year and I guess I'd better think about saving more money, too.

Ralph: You're both thinking too far in the future. A car can be used right now. School is a long way off -- and who knows if it will even work out?

This is a hypothetical situation and may not even seem realistic to you. But can you see any possibility that Ralph's attitude might change if this conversation were to continue? What relationship would possible attitude changes have to energy consumption? Were these people even thinking about energy use in making their decisions? Have you ever had conversations that were similar to this one? Have your own attitudes ever changed because of someone else's ideas?

What if the hypothetical conversation had gone like this:

Ralph: I'm going to get rid of my gas burner.

Tom: How come?

Judy: I'll bet it's because he wants to save a little cash, with gas being the price it is.

Ralph: That's mostly right, and I think my bike will do for getting around school. When I need a car for a date my old man will come through.

Tom: That's good thinking, what with the energy shortage and all.

How are the two conversations alike? Different? Is this kind of talk realistic? Try analyzing the real discussions that occur among you and your friends. What attitudes and feelings enter into such discussions? Do individuals ever change their attitudes?

<u>What Do You Think?</u>

We may sometimes get the feeling that we are not responsible for our own attitudes. Someone else seems always to be setting the rules, applying the standards, or making the decisions. We may even wonder about some of the things we believe most deeply. Is the belief truly ours, or did someone

else condition us to think and act in certain ways? Some people even maintain that individual beliefs are insignificant "since one person can't make all that much difference, anyway."

Questions and concerns such as these are normal and healthy. In fact, self-questioning is one important way of better understanding our own attitudes and behaviors. Applying this idea to energy-related questions, you might choose to ask yourself, "Why do I want a car, stereo, motorcycle, or _____?" "Am I considering everything that is relevant to the decision?" "Do I have alternatives that I haven't considered that might be just as good?" "What are the trade-offs? Am I losing something in order to gain something else?"

What Do Others Think?

The analysis of attitudes and feelings is one important step toward better understanding of personal, local, national, and global decision-making activities. With energy issues, as with all societal questions, attitudes are a powerful, but sometimes hidden, part of the equation. As you conduct your energy investigation, you are likely to encounter a wide range of attitudes. Chapter 3 in this book suggests some ways of surveying public opinion. Chapter 13 provides some techniques you can use to study in greater depth the role of attitudes and values in the decision-making process.

11. HEALTH AND SAFETY

The conditions of good health and reasonable freedom from danger are considered among the most valuable of human rights. A major portion of human effort in research, development, and clinical application has been devoted to attempts to protect and extend life. In recent years, a greater share of that effort has been given over to problems of mental, rather than physical, illness.

Safety from external danger has taken on new meanings as social systems have become more complex and technologically oriented. Death and injury from automobile accidents, for example, reach more than four million persons annually. Fire hazards in crowded cities threaten more individuals than in less crowded areas, and impurities in a city's water supply could spell disaster for millions.

This chapter suggests just a few of the areas in which standards must be determined and applied if human life and health are to be protected. Some possible relationships between energy uses and health and safety are also outlined. You will certainly be able to think of others and to find additional sources of information on these topics.

Definitions and Explanations

Health

The term health implies a normally functioning body and mind. Thus, a person who is healthy maintains a balanced interaction with the environment. Although these interactions may occasionally mean dealing with physical or emotional stress, the healthy individual can respond to the stresses, returning quickly to a balanced and normal state.

People interact with the environment in many ways, including

1. *Inhaling and exhaling air.* This process supports the respiratory function in which oxygen is supplied to the tissues and carbon dioxide and other wastes are removed. The adequacy of respiration to maintain body health depends on (a) the proportion of oxygen and other substances in the air, (b) the purity of the air inhaled, i.e., freedom from substances that may be damaging to the tissues, and (c) the ability of the lungs and tissues to absorb needed materials and to discharge wastes.

2. *Maintaining a selective barrier against infectious organisms and poisonous materials.* This is the primary role of the skin and the membrane tissues associated with body openings. While these barriers are normally effective, they can be damaged by cutting, piercing, or scraping. In addition, certain kinds of harmful radiation can pass through the skin leaving no sign of passage.

3. *Ingesting food and water and eliminating wastes.* Although the body's mechanisms for absorbing vital materials and eliminating others are remarkably efficient, toxic materials can enter the tissues in spite of these defenses. While the body has other internal defenses against some toxins, the quantity and type of toxin entering the tissues may determine the difference between health and disease or life and death.

4. *Sensing and responding to external stimuli.* This interaction covers the whole range of senses including vision, hearing, feeling, tasting, and smelling. These senses, and the responses associated with them are ordinarily sharp and effective. They can, however, be dulled or eliminated by overstimulation, understimulation, and physical or chemical damage.

5. *Adapting to social and psychological situations.* The range of human ability to learn -- and to modify behavior in response to learning -- is unique in the animal world. While highly organized societies do exist in lower animal forms, the variability, adaptability, and complexity of human social systems is unequaled among living things. This complexity is made possible both by human physical and mental capabilities and by the diversity of situations that challenge human reasoning. Nevertheless, because of enormous individual variability, some situations are more stressful to some people than others. This diversity of abilities to "cope," and of mechanisms for coping, makes research into questions of emotional and social health one of man's most challenging and most vital concerns.

Safety

The idea of safety implies that we must first predict situations in which the possibility of harm exists, and then select measures that eliminate or lessen the likelihood of the danger. To be safe, therefore, is to be out of danger. The relationship to factors described in the discussion of health above should be obvious. Other situations in which the term is used

depend on interpretations of words. For example, a business operation could be "dangerously in debt," or operating at "safe" levels of financial "health." In this module, ideas such as these are excluded from the health and safety factor category. Danger is interpreted to mean dangerous to human physical and mental well-being.

Safety standards can never be absolute; they must be based on probabilities. We know, for example, that people are more likely to fall on uneven stairs than on stairs that are uniform in size and pitch. Building even stairs does not, however, assure that no one will ever fall on them. Similarly, installing and using seat belts in automobiles reduces, but does not eliminate, the possibility of death in an accident. No situation is ever absolutely safe. Some are simply safer than others.

Health, Safety, and Energy Questions

You may be wondering in what ways energy resources and uses relate to concerns about health and safety. The key to the relationship lies in the fundamental idea of the human organism interacting with the physical environment. The following list suggests some possible areas of inquiry and concern for health and safety questions:

1. *Transportation.* Huge amounts of energy are used to move people and materials from place to place. How safe are various forms of transportation? What health effects result?

2. *Home energy use.* Some uses of energy in the home actually promote healthy conditions: for example, air conditioning, high temperature dish-washing, and humidifying. Are there other uses that may threaten health or reduce home safety?

3. *Energy use in industry.* Governmental and private organizations have developed detailed safety codes for industries. Millions of dollars are spent each year to improve industrial safety standards. Direct energy industries, such as coal mining, have been severely attacked on safety and health issues.

4. *Energy use in business.* Many of the questions and concerns that relate to energy use at home and in industry also apply to the commercial sector of society.

5. *Fossil fuel utilization.* Concern here is primarily with environmental effects which can produce situations hazardous to health. Some health problems associated with air and water pollution are known, but much has yet to be learned.

6. *Alternative energy sources for the future.* Debate is still raging over the question of radiation hazards from nuclear power plants. Opinions vary, also, on the likelihood of a nuclear accident that could injure or kill millions. What health and safety problems do you think might be associated with geothermal plants, MHD, dams, solar power plants, etc.?

Some Sources of Information about Health and Safety in Relation to Energy Use

National Safety Council

World Health Organization

American Cancer Society

March of Dimes Committee for Respiratory Disease

National Lung Association

Environmental Protection Agency

National Labor Relations Board

U. S. Department of Labor, Occupational Safety and Health Administration

12. DESIGN AND TECHNOLOGY

Questions of energy resource development, use, and conservation are inevitably linked to the effects of design and technology. When a new automobile first appears on the showcase floor, even the unsophisticated shopper is usually attracted first to overall design features, such as styling, then to those qualities of design that promise to provide comfort, ease of operation, efficiency, low maintenance costs, durability, and economy of operation. The care with which we choose among the many advantages and alternatives offered suggests our appreciation for the benefits to be derived from creative design and from new and more versatile technology.

The example of the automobile is only one of thousands that we encounter on a day-to-day basis. This pattern of selective behavior has developed from very simple beginnings to almost unbelievable complexity. The fundamental purpose of technology appears to have been the achievement of a more satisfying and comfortable existence through modification of the physical environment. Technology began with the primitive tools to accomplish basic goals such as acquiring food, achieving personal safety, securing shelter, and reducing the total amount of time and effort that had to be spent in doing those things. The record of human progress in regard to technology is marked by many significant achievements that have had far-reaching and long-lasting effects. The simple distinction between the ability to *find* a useful stone and the ability to *shape* a stone for a specific purpose or need may help to explain our present day concept of progress. "Progress," used in this sense, implies an improvement in the ability to control the environment instead of being controlled by it.

Agriculture provides an excellent example of rapid advance in technology. We must assume that many edible plants were discovered by chance and that human migrations about the earth were, at least in part, related to the constant search for food, shelter, and safety. We know that these motives for behavior still function in human societies. We know, also, that at some point people discovered the process and the advantages of planting, cultivating, and protecting their own plant food supplies, and that they supplemented this with the more difficult practice of domesticating animals for meat.

The many tools that have been developed and applied to improve agriculture attest to the power of human beings to learn from observation and experience and to the talent for invention.

The wealth and power of nations have been gained and lost as the balance of technological effectiveness and efficiency has shifted. These shifts have often been the result of discovery and invention; but even more often, they have been the consequence of innovation in *design*. The Wright brothers achieved their goal of inventing a flying machine, but today's jets do much more than just fly. Through a complex series of improvements in design, the "flying machine" achieves capabilities that the Wright brothers could hardly have imagined. Thus, given a fundamentally workable idea, creative design can expand and multiply the effectiveness of the idea.

It is useful to take a look at the consequences of progress in technology and design. Machines require energy to do work, even the simplest machines. Progress, as we have always viewed it, releases people from using their own energies and uses, instead, energy from external sources. Noting that the most convenient and most plentiful sources of energy were almost always the cheapest, it is not surprising that developed nations have moved from the use of wood to coal and then to oil and natural gas as convenient sources of energy. It is also not surprising that the technologies developed to obtain and use these easy and cheap sources of energy have been some of the major beneficiaries of design modifications. Transportation, communication, building, industrial productivity -- all have contributed to massive increases in our ability to obtain energy from the natural environment. At the same time, these increased energy supplies have encouraged human societies to find more ways to put this cheap and easy energy to work. Electric motors, for example, can be made to perform thousands of routine tasks by simply reorganizing the gears and levers. With miniaturization, the number of potential jobs for the same electric motor have been multiplied by additional thousands.

How are such developments explained and justified? At least in part, it can be said that human inventiveness has improved quality of life. A remarkable array of tasks are done by a simple flick of a switch, lessening drudgery and saving time. Even in those areas where control of natural forces

continues to be beyond human capacity, millions of hours are spent yearly in research dedicated to removing these last barriers. Computer technology, extended beyond its basically simple mathematical functions, serves to store fantastic quantities of information and provides almost instantaneous and selective retrieval and analysis. The multiple uses of new technology in the last thirty years have increased human capabilities tremendously. One example is the NASA space program which has successfully landed men on the moon and returned them to earth with accuracy, efficiency, and safety. Without the computer, this would have been beyond the imagination. With modifications, the skills and techniques developed for the space program are being applied in thousands of ways to other aspects of human life -- in agriculture, business, industry, medicine, education, and countless other fields.

It would be strange, if not foolish, to treat such achievements as anything other than admirable. Looking back at the brief span of time in which these advances have been made suggests that we may only have scratched the surface of human potential for technological achievement; and who would not want to know what the future has to offer? But there are disturbing factors to be considered in regard to continued "progress," and energy resource depletion is an important one. The amount of energy that may be required to sustain such a rapid pace of technological development is a critical question. Can alternative sources be developed quickly enough? Can the costs of alternative sources be absorbed by an economic system built around much cheaper fuels? How we react and respond to these questions may determine whether we actually deserve the advantages our technology has provided.

One other example may help to clarify the issues. Architecture is the art and science of design and construction. Architects are inspired by many motives, including those concerned with the creation of useful, impressive, beautiful, and unusual structures. Granted, the usual idea is to create forms that satisfy basic needs, using available materials that are appropriate to the required setting. Nevertheless, there is evidence that buildings of recent design require substantially more energy to assemble and construct than is necessary, not to mention costs of operation of the structures once they are built. It has been estimated that architecture, including all three of these processes, accounts for more than one-third

of all energy use in the United States.*

This suggests at least one area in which design and technology might be re-evaluated in terms of energy use. Designs for efficiency in construction and operation must be enlarged to include the higher value of our limited supplies of energy; i.e., our ability as a nation to replace that amount of fuel energy from nonrenewable resources, or from hitherto untapped sources.

There are, of course, hundreds of aspects of design that are affected by questions related to energy efficiency: whether to use glass or concrete, whether 105 stories on one acre or 10 stories on 10 acres, whether to use high or low ceilings, direct or indirect lighting, and how to respond effectively and efficiently to variations in heating and cooling needs. These and many other problems of design pose obvious questions about energy use and resource depletion. How we use our technological and design capabilities should, perhaps, be viewed as a two-headed monster, a creature at the same time beautiful yet dangerous.

This brief discussion and the examples given serve only to illustrate a few of the questions that you may need to explore in your investigation. It may be that technology will provide an answer to the question of scarce resources in time to avoid a major energy crash. Or it may happen that changes in values and life styles -- either voluntary or forced -- will occur in response to the rapid depletion of energy reserves. What do you think of these possibilities? What technological and design options are now available? What choices can be made now and in the future?

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* Stein, Richard G. Architecture and energy. *Architectural Forum* 138:43 (1973).

13. VALUING AND DECISION MAKING

As you may recall, the major purpose of your work so far -- indeed, of this module -- has been to provide opportunities for you to gain experience with the process of decision making. You have discussed information and opinions on energy questions. You have learned something about sources of energy and how we use those sources. For the last few weeks, you have been collecting, sharing, and analyzing data related to the energy questions you and others have chosen to investigate. You may have considered topics as closely related as environment and health and as divergent as engine efficiencies and governmental structure. Although you may now have a great deal of information about your problem area, you certainly cannot have it all. For one thing, even if you have searched very carefully and found much, there are many things about energy questions that *no one* knows. The data simply are not available.

Whether we like it or not, knowledge is always incomplete. Individuals and societies must often make decisions based on what they can reasonably predict rather than on sure and certain knowledge. This state of inevitable doubt does not justify rash actions or poorly conceived decisions. On the contrary, having less than sufficient information requires that each of us be more careful, more thoughtful, and more critical either of the decisions we make or of those we support.

Given the data that you have collected so far, you must now attempt to prepare a hypothetical recommendation for your community. Ask yourself, "If I could give some advice to my community about what we should do, what would my advice be?" Each member of your team should consider the same issue and, through discussion, attempt to arrive at a recommendation or series of recommendations for your community. The process described below can be used in your discussions to help you describe and take into account your values and those of your community. It is possible, through this process, to arrive at different conclusions from the same data, based on different sets of values. But once people identify their values and describe them honestly, they can begin to improve their understanding of both the nature of the problems at hand and the many reasons that may support different positions on the same issue.

Your teacher will distribute to you a Values Analysis Scale like the one below. Notice that there are two columns, one for listing those results of an action that are deemed positive, and one for those that are considered negative. There are 20 points in the values scale. An effect considered extremely negative gets a -10; one considered highly desirable or positive gets a +10. A result having no effect, either positive or negative, rates a 0. Moderately or slightly negative effects might get something between 0 and -10. Moderately or slightly positive effects can be rated +1 to +9 on the positive scale.

VALUES ANALYSIS SCALES

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10

ENERGY-RELATED DECISION

List and assign Negative effect values:	List and assign Positive effect values:
Total:	Total:

Let's consider two examples of this scale prepared by two student groups looking at similar questions. Remember, these are *only examples*. There is no intent here to indicate "right" or "wrong" positions on these issues. After you have studied the examples, think and talk about the questions below. Once you feel comfortable with the examples and the general procedure, go ahead and prepare values scales for yourself and for questions being considered by your group. What will your recommendations be?

Questions for Discussion

1. The questions being considered in the two examples are slightly different. How might this difference relate to the differences in response?
2. Considering the totals of the positive and negative scores, what do you think each student group is likely to recommend to the community?

EXAMPLE I

VALUES ANALYSIS SCALES

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10

SHOULD A LAW BE PASSED IN MAPLETON PROHIBITING THE USE OF

CARS FOR SHORT TRIPS UNDER FIVE MILES?

List and assign Negative effect values:		List and assign Positive effect values:	
IMPOSSIBLE TO ENFORCE	-10	SAVES GASOLINE	+8
MOST PEOPLE WON'T LIKE IT, OR DO IT	-8	SAVES MONEY	+5
WILL HURT MOST OF THOSE WHO MAKE A LOT OF TRIPS	-5	LESS AIR POLLUTION	+6
TAKES TOO MUCH TIME	-10	CARS WOULD LAST LONGER AND NEED FEWER REPAIRS	+4
POLICE WOULD SPEND TOO MUCH TIME TRYING TO ENFORCE	-4	A CHANCE TO RELAX AND ENJOY THE SCENERY	+3
PEOPLE WOULD SHOP LESS AND ECONOMY WOULD GO DOWN	-7		
Total:	-44	Total:	+26

EXAMPLE II

VALUES ANALYSIS SCALES

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10

SHOULD PEOPLE IN MAPLETON GIVE UP THEIR CARS

FOR SHORT TRIPS UNDER FIVE MILES?

List and assign Negative effect values:		List and assign Positive effect values:	
BUSSES AREN'T AVAILABLE FOR THE ELDERLY	-6	REDUCED AIR POLLUTION	+10
TAKES TOO MUCH TIME	-5	FEWER ACCIDENTS	+10
INCONVENIENT	-3	WALKING/BICYCLING ARE GOOD EXERCISE	+8
REDUCED GASOLINE TAX MEANS FEWER NEW ROADS OR ROAD REPAIRS	-3	MAPLETON IS SMALL SO MOST TRIPS ARE SHORTER THAN THAT ANYWAY	0
PEOPLE WOULD STAY HOME MORE AND JUST CONSUME MORE ENERGY THERE	-4	WOULD SAVE A LOT OF GAS	+7
		PEOPLE WOULD SAVE MONEY	+5
Total:	-21	Total:	+40

3. Look at the values assigned each item on each scale. What can you infer about the opinions of each group? In what ways do the values of the two groups seem to differ?

4. If you were working on the same questions, which scale would most closely resemble yours? What differences would there be? How would these differences relate to the value you place on certain attitudes and feelings that you have?

5. Which example do you think more nearly approximates the values of your community? Do any of the data you have collected on attitudes and feelings in your own community relate to the questions considered in these examples?

6. What important factors are missing from these scales? How would the addition of these elements affect the decisions?

14. CONSTRUCTING AND ANALYZING POSSIBLE ENERGY FUTURES

In the work you have already done, you have had opportunities to learn something about energy and about how decisions relating to energy questions can be made. By now you probably realize that energy questions are complex. And that, to find the answers, you need information about politics, economics, social attitudes, technology, and other factors. Furthermore, you may have discovered that such information alone is seldom sufficient for the decision-making process. In making a recommendation for your community about your problem area, for example, you probably found that you had to decide that some things were more important than others or that people in your community would probably place a higher value on one factor than on another.

But there is one part of the picture that you may not have given much attention to so far. This important concern is *time*. Have you begun to think about how actions today may affect the world of tomorrow?

Making predictions about the future can be fun, but it can also be informative. Many scientists use prediction as a tool, even now. Computers can be used to help generate models of what the world will be like in the future if present trends continue, increase, or decrease. (See for example, *Limits to Growth*,* a detailed computer-generated prediction of possible futures given present trends in fuel and resource consumption, population growth, etc.) When we force ourselves to think about long-term consequences, we sometimes see problems in our decisions that we didn't recognize before.

Suppose, for example, that our country today decides that there is no real need to conserve gas, oil, and coal, because there are probably vast reserves of these resources that just have not been found yet. Looking into the future, what might you see as logical outcomes of that decision now? Several outcomes are, of course, possible. It could be that vast new reserves will be found. But one might also predict, assuming we

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*by D. H. Meadows, et al. New York: New American Library, Inc. c 1972 by Dennis L. Meadows.

continue to use fossil fuels, that supplies *must* run out sometime, even if many thousands of years from now. What, then, would such a world be like? Again, there are a number of possibilities that could be identified and analyzed. That distant world might run on solar or nuclear power, or perhaps on a source we don't even know about now.

What might that future society be like? Would there be "charging stations" instead of filling stations for automobiles? Or would automobiles have been replaced by solar or nuclear trains, with solar collectors or small reactors mounted on their roofs? Would houses be both heated and cooled by solar or nuclear power, or would something else be used for that purpose? Would cooking be a thing of the past? Would the air pollution problem have been solved? Would people's attitudes and beliefs be any different? How might they view energy use attitudes of the past? Would they think us wise, clever, wasteful, naive, inventive, or uninspired?

In a way, this is science fiction. Science fiction at its best uses existing scientific knowledge as a basis for making logical and internally consistent predictions about the future. Although sometimes fanciful, good science fiction always characterizes a future world and the people in it in a way that shows the relationship of the physical, economic, and political environment with the behavior and feelings of the people in that environment. There are no contradictions. Consider, for example, this passage from "Twilight" by John W. Campbell, Jr.*

> "Twilight -- the sun has set. The desert out beyond, in its mystic, changing colors. The great, metal city rising straight-walled to the human city above, broken by spires and towers and great trees with scented blossoms. The silvery-rose glow in the paradise of gardens above.
>
> "And all the great city-structure throbbing and humming to the steady gentle beat of perfect, deathless machines built more than three million years before -- and never touched since that time by human

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*Reprinted with permission of Margaret W. Campbell. c 1951. The complete story appears in Campbell, John W., Jr. *Who Goes There? Seven Tales of Science Fiction.* 2nd ed. Chicago: Shasta Publishers.

hands. And they go on. The dead city. The men that have lived, and hoped, and built -- and died to leave behind them those little men who can only wonder and look and long for a forgotten kind of companionship. They wander through the vast cities their ancestors built, knowing less of them than the machines themselves.

"And the songs. Those tell the story best, I think. Little, hopeless, wondering men amid vast unknowing, blind machines that started three million years before -- and just never knew how to stop. They are dead -- and can't die and be still."

What was the author saying about the projected world he has created? What did he imply about its people. Most importantly, what decisions made in the past -- before this world ever came to be -- might account for what has happened as Campbell describes it?

Option A

You may come to understand a great deal more about your particular problem area or the energy question in general by attempting to construct some description of a hypothetical future world. You can choose whatever medium appeals to you most and fits your ideas best -- perhaps a play, a short story, a song, a model city, a slide presentation (or slides with a taped soundtrack), posters, picture collections, scrapbooks, a speech, or simply a written or verbal description of the world you think might exist in the future if certain energy decisions are made (or are *not* made) now.

Whatever medium you choose to use in presenting your ideas, there are some important steps that you should take in developing the prediction. Begin by listing all the present energy decisions that you intend to use as the basis for your future world. For example:

If we decide now to

1. ration gasoline,
2. reduce air pollution to ten percent of its present level,
3. invest enormous amounts of tax money in solar energy research,...

what would this country or the world be like 50, 100, or 500 years from now?

Or, using another set of present decisions as an example:

If we decide now to

1. use military and economic power to obtain petroleum from other countries;
2. seek ways of developing oil and natural gas synthetically;
3. design cars that are faster, yet safer;
4. lower or eliminate air pollution standards to allow for increased use of "dirtier" fuel,...

what are some of the conditions and situations that might exist at some future time?

These examples only suggest a way of beginning your prediction of the future, not any particular assumptions you should make. Just begin by listing a few energy decisions that society could make now. Then ask yourself how those decisions might affect people sometime in the future.

As you develop your story or other kinds of presentation, pay particular attention to two things: the physical environment and the people. Try to describe what transportation, recreation, housing, entertainment, industry, commerce, and other forms of activity that show up as tangible objects in the physical environment might be like. You should also try to think about the natural part of the environment. Would there still be animals, trees, and rivers, or would something else exist in their places? Secondly, pay attention to what the people in this future world would be like. What things would they care about? What things would they consider most important? Would they work and play as we do, or would these activities exist in different forms, or not at all? What things would they consider necessities? What things would be luxuries? Would they want the same things you do or different things? Would they be "happy" in the way you would define it, or would they have another idea about what happiness is?

If you pay attention to these and other things as you design your prediction, you will already be on your way to the third step in designing and judging your possible future world. After you have devised your future world, you should identify some very specific ways of evaluating or judging it. You need criteria for deciding and explaining what is good about the world and what is bad about it. You will need to state clearly your reasons for making your judgments. For example, suppose you developed

the following list of criteria for judging a possible future:

For this world to be a good one, people should have

1. easy, quick, comfortable transportation;
2. leisure time for recreation and study; and
3. clean air and water.

For instance, looking back on one future model which, by virtue of decisions made in previous years, still had fossil fuel powered automobiles that were cheap and readily available to everyone, you might decide that the first criterion had been met. If, however, economic conditions were such that people had to work long hours for most of their lives (perhaps to maintain an automobile industry grown out of proportion) and increased use of automobiles had led to unbreathable air and undrinkable water, you might decide that the last two criteria had not been met. You might conclude that the quality of life in this possible future would not be what you would like.

Option B

There is an alternative approach to this activity. Rather than prepare a model or presentation of your own, you might prefer to search out and analyze a future model that someone else generated at some time in the past. People have been predicting the future perhaps since the beginning of humanity -- but over the years these predictions have become increasingly significant. The predictions of Leonardo da Vinci about submarines and airplanes may have actually helped these things come about -- a hypothesis that seems especially reasonable when we consider the fact that da Vinci designed an airplane and actually built and operated a submarine.

You may be familiar with the work of Jules Verne, the nineteenth century fiction writer who postulated nuclear submarines, airplanes and time machines. Other writers have taken a harder look at people than at the technology of some future time. Aldous Huxley's *Brave New World* and Ray Bradbury's *Fahrenheit 451* are good examples of such people-oriented projections of the future.

If you would rather look at someone else's prediction than design your own, find a novel, short story, or historical account (perhaps even in old newspapers) of some prediction. Analyze the prediction just as you would

your own. Begin by listing all the "ifs." What past decisions, conditions, or trends was the author or inventor assuming applied to his future world? What did the author say or imply about the physical and natural environment and the people in that environment? What criteria did the author use -- or what criteria of your own might apply -- to judge what is desirable or undesirable about this possible world?

Whichever option you choose, remember the three steps:

1. List all the "ifs" -- past decisions that affect the hypothetical future.
2. Characterize (or analyze) the environment and the people.
3. State and apply a set of criteria for judging that future world.

Present your own predictions or your analysis of someone else's future world to the class. How do others react to the conditions and situations of the future you have designed or analyzed?

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